Maritime Electronic A/S
Ref. 24500

TF 2950

Mobile Radio Test Set

INSTRUCTION MANUAL
(OPERATION)

MARCONI INSTRUMENTS LIMITED

Instruction Manual

NO. E.B. 2950

for

Mobile Radio Test Set

TF 2950

MARCONI INSTRUMENTS LIMITED
ST. ALBANS HERTFORDSHIRE ENGLAND

M.I. 1c
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Contents

Chapter 1

General information

1.1 INTRODUCTION

The Mobile Radio Test Set, TF 2950 has been designed as a fully transistorised, multi-purpose unit capable of being driven from its own rechargeable batteries. The main application is for the testing, adjustment and servicing of mobile radio communications equipment operating in the VHF and UHF frequency bands.

As a multi-purpose instrument the TF 2950 contains five units which are as follows:-

1) An AM/FM signal generator covering the appropriate mobile radio VHF and UHF communications bands.

2) A modulation monitor for the measurement of amplitude modulation depths up to 80% and peak frequency deviations up to ±25 kHz.

3) An in-line power meter with a separate 15 W r.f. load.

4) An audio voltmeter having a sensitivity of 10 mV f.s., an input impedance of 100 kΩ and a bandwidth of 20 kHz.

5) An audio oscillator with a nominal frequency of 1 kHz which is adjustable by up to ±1% and an output level variable up to 3 V.

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1.2 DATA SUMMARY

AM/FM SIGNAL GENERATOR

Frequency Ranges:	65-84-108 MHz. 140-180 MHz & 420-470 MHz.
Frequency Dial Accuracy:	±0.5% of dial setting.
Frequency Stability:	Typically 25 p.p.m. per 10 minutes after 15 minutes warm-up.
Electrical Fine Tuning:	±20 kHz directly calibrated on all r.f. ranges.
Accuracy:	±20% of f.s.
R.F. Output Level:	Continuously variable from 0.1 μV to 10 mV p.d. across 50 Ω.
Output Impedance:	Nominally 50 Ω.
R.F. Level Accuracy:	±3 dB ±0.1 μV.
R.F. Leakage:	Using a two turn 25 mm diameter search loop feeding into a receiver with a sensitivity of 1 μV no signal can be detected at a distance of 25 mm.
Amplitude Modulation Depth:	Continuously variably up to 50% depth on all r.f. ranges up to 180 MHz.
Accuracy:	±10% of f.s.
Internal Modulation:	At 1 kHz with a +1% variable control.
External Modulation:	A.C. coupled 100 Hz to 5 kHz.
Spurious F.M. on A.M.:	Less than 1 kHz at 30% modulation depth.
Frequency Modulation:	Continuously variable up to ±25 kHz peak deviation.
Deviation Ranges:	0 to 5 kHz and 0 to 25 kHz.
Accuracy:	±10% of f.s.
Internal Modulation:	At 1 kHz with a ±1% variable control.
External Modulation:	A.C. coupled 100 Hz to 5 kHz.

MODULATION MONITOR

Carrier Frequency Ranges:	65-85-108 MHz, 140-180 MHz & 420-470 MHz.
Frequency Deviation Ranges:	0-5 kHz and 0-25 kHz.
Accuracy:	±5% of f.s. for sinewave modulation signals.
Dial Accuracy:	±1% reading
F.M.R.F. Input Sensitivity:	10 mV
Maximum Input:	1 V
Amplitude Modulation Depth Range:	0-80%
Accuracy:	±10% of f.s.

A.M. R.F. Input Sensitivity:	50 mV
Maximum Input:	1 V
Monitor Indication:	Positive and Negative peak deviation. Peak and Trough Amplitude Modulation Depth.
Demodulated Output:	Available at front panel sockets with internal loudspeaker.

R.F. POWER METER

Frequency Ranges:	65-180 MHz and 420-470 MHz.
Power Measurement Range:	0-25 W under through-line conditions. Using internal R.F. load 0-15 W continuous operation and up to 25 W for 3 minutes.
Power Indication Accuracy:	±10% of f.s.
Input Impedance:	Nominally 50 Ω.

A.F. OSCILLATOR

Frequency:	1 kHz with a ±1% front panel variation control.
Output Level:	Continuously variable up to 3 V.
Ranges:	3, 30, 300 mV and 3 V f.s.
Output Level Accuracy:	±5% of f.s.
Output Impedance:	200 Ω on the 3 V range, 40 Ω on all other ranges.
Distortion:	Less than 1%

AUDIO VOLTMETER

Voltage Ranges:	10, 30, 100, 300 mV and 1, 3 and 10 V f.s.
Accuracy:	±5% of f.s.
Input Impedance:	Nominally 100 kΩ.
Frequency Range:	100 Hz to 20 kHz.

POWER SUPPLIES

Internal rechargeable cells giving 6 to 8 hours operation mains supply for recharging:	100 V ±15% or 220 V ±15%. 40 to 50 Hz. 10 W.

DIMENSIONS & WEIGHT

Height	Width	Depth	Weight
31.5 cm	42 cm	23 cm	16 kg
(12 in)	(16 in)	(9 in)	(35 lb)

1.3 ACCESSORIES SUPPLIED

Mains lead.
3 free B.N.C. Plugs.
Power meter link (50 Ω)
4 wander plugs.

Chapter 2

Operation

2.1 PREPARATION FOR USE

In common with other apparatus employing semiconductor devices, the performance of this instrument may be affected if it is subjected to excessive temperatures. Therefore completely remove any covering from the instrument and avoid use whilst standing on, or close to, other hot equipment.

2.2 POWER SUPPLIES

Unlike most other instruments the supply switch has three positions, ON, OFF and CHARGE and controls the power supply to the Test Set. With the switch in the ON position the power required is drawn from the internal rechargeable batteries. If the mains supply is connected to the MAINS INPUT SOCKET the batteries will still be the source of supply for the test set but will be automatically trickle charged.

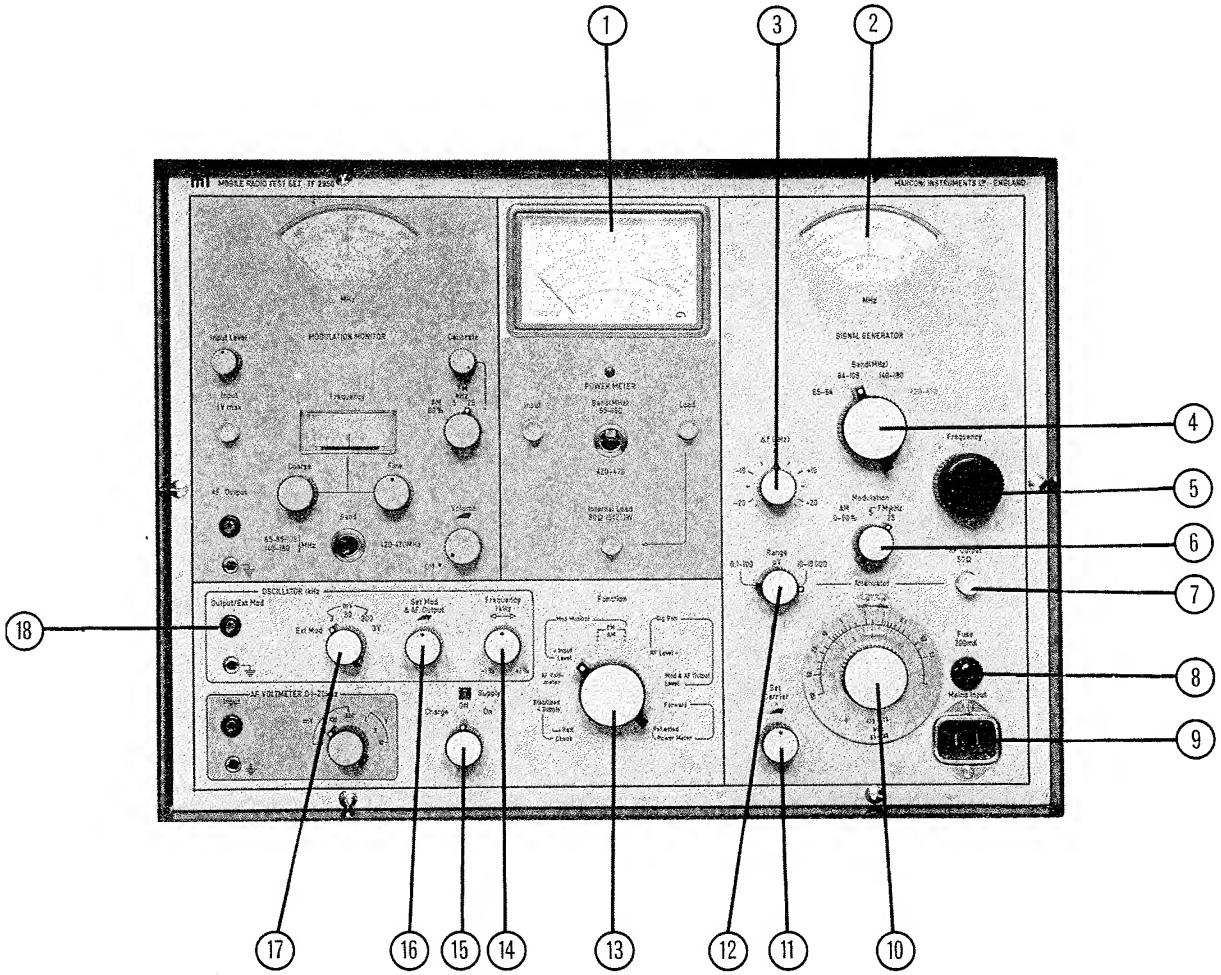
With the supply switch set to the CHARGE position the batteries are disconnected from the test set and charged at a much higher rate. A protection circuit is fitted to prevent any battery damage that may otherwise be caused by overcharging.

When the instrument is to be used, the condition of the batteries should be checked. In order to do this the 'FUNCTION SWITCH' must be set to the 'BATT CHECK' position. The meter should then read in the 'BATT' arc on the meter scale. If it does not the battery should be recharged by connecting the mains supply to the Test Set and switching to the CHARGE position. Once charged the batteries will last from 6 to 8 hours without further charging. Should the batteries become fully discharged it will take approximately 8 - 10 hours to fully recharge them.

To prevent damage to the batteries they MUST NOT be left in an uncharged condition.

Once the batteries are charged the FUNCTION SWITCH is then set to the STABILISED SUPPLY position to check the voltage stabiliser operation. The meter should indicate on the RED DOT in the centre of the meter scale. If it does not a fault condition is indicated and the Test Set should be switched OFF.

2.3 SIGNAL GENERATOR CONTROLS



2.3.1 Signal Generator Operation

1.	Test Set Meter	-	This is a multi-purpose monitor which indicates carrier reference level and modulation level in the signal generator mode.
2.	Frequency Dial	-	Indicates output carrier frequency.
3.	Electrical Fine Tuning Control	-	This is calibrated directly in kHz independent of carrier frequency.
4.	Frequency Range Switch	-	Selects appropriate carrier frequency range 65-84 MHz, 84-108 MHz, 140-180 MHz or 420-470 MHz.
5.	Coarse and Fine Frequency Control	-	A two speed mechanised drive.
6.	Modulation Selector	-	Allows either the amplitude modulation or frequency modulation modes to be selected.
7.	R.F. Output Socket	-	50 Ω B.N.C. socket.
8.	Mains Fuse		
9.	Mains Input Socket	-	Mains supply input for battery charging circuit.
10.	R.F. Output Level Control	-	Variable attenuator, calibrated directly in p.d. across a matched 50 Ω load.

11.	Set Carrier Level Control	-	Used to bring the carrier level monitor to the reference mark (Red Dot).
12.	R.F. Output Level Range Switch	-	Selects 0.1 μV to 100 μV or 10 μV to 10 mV ranges.
13.	Function Switch	-	Selects Test Set Function.
14.	Modulation Oscillator Frequency Control	-	Allows internal 1 kHz modulation oscillator to be adjusted by up to $\pm$1%.
15.	Supply Switch	-	Selects OFF, ON or CHARGE functions. In the OFF position all supplies to the instrument and the battery trickle charger are switched off. In the ON position all test set functions are driven from the internal rechargeable batteries. When the mains supply is connected the battery is being trickle charged. In the CHARGE position all functions are switched off but the battery is charged at a higher rate than trickle charge.
16.	Modulation/Audio Oscillator Level Control	-	Adjusts amplitude modulation depth or peak frequency deviation.
17.	External Modulation Selector	-	Selects external modulation function or audio oscillator output level.
18.	External Modulation Terminals	-	Allows the signal generator to be externally modulated from a 300 Hz to 5 kHz source.

When the signal generator is to be used the FUNCTION SWITCH should be set to the R.F. level position. No modulation is available in this position. The appropriate carrier frequency can now be selected with the FREQUENCY RANGE SWITCH and the COARSE AND FINE FREQUENCY CONTROL. Indication of the selected frequency appears on the FREQUENCY DIAL.

Once the frequency has been set accurate frequency changes up to a maximum of $\pm$20 kHz can be achieved by use of the ELECTRICAL FINE TUNING CONTROL which is calibrated directly in frequency change.

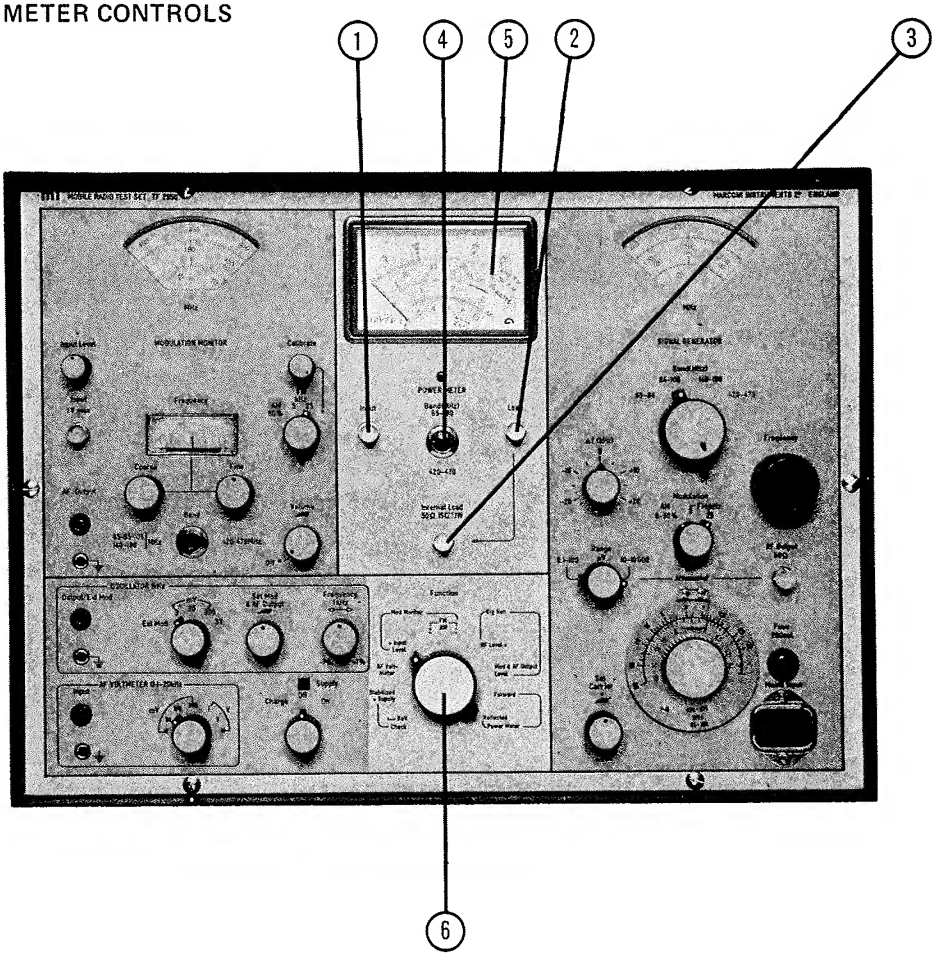
The SET CARRIER LEVEL CONTROL should now be adjusted to bring the meter to the reference mark i.e. the RED DOT. Once this has been carried out the CARRIER LEVEL RANGE SWITCH and the OUTPUT LEVEL CONTROL can be used to set the output voltage to the required value as indicated on the attenuator dial, which is calibrated in terms of p.d. across a matched 50 Ω load.

Two coloured scales are provided on the dial. Black for use up to 180 MHz carrier frequency and Red for 420-470 MHz band. The legend around the FREQUENCY RANGE SWITCH is similarly colour coded.

If modulation is required the FUNCTION SWITCH is set to the MOD AND A.F. OUTPUT LEVEL position. The type of modulation required can then be selected with the MODULATION SELECTOR, which automatically sets the monitor full scale. Ranges of 0 to 50% amplitude modulation depth on 0 to 5 kHz and 0 to 25 kHz peak deviation are available. The modulation depth or peak deviation can be adjusted with the SET MODULATION LEVEL control.

In order to facilitate measurements where accurate adjustment of the modulation frequency is necessary i.e. SINAD measurements, the MODULATION FREQUENCY CONTROL can be used to vary the internal 1 kHz modulation oscillator ±1%. When other modulation frequencies are required the EXTERNAL MODULATION function position should be selected and an external oscillator of the required frequency used to modulate the signal generator. Frequencies between 300 Hz and 5 kHz can be used under these conditions.

2.4 R.F. POWER METER CONTROLS



1.	R.F. Input Socket.	50 Ω B.N.C. Socket
2.	Thruline Output Socket	50 Ω B.N.C. Socket
3.	50 Ω R.F. Load Input Socket	50 Ω B.N.C. Socket
4.	Frequency Range Switch	
5.	Power Indicator	
6.	Function Switch	

2.4.1 R.F. Power Meter Operation

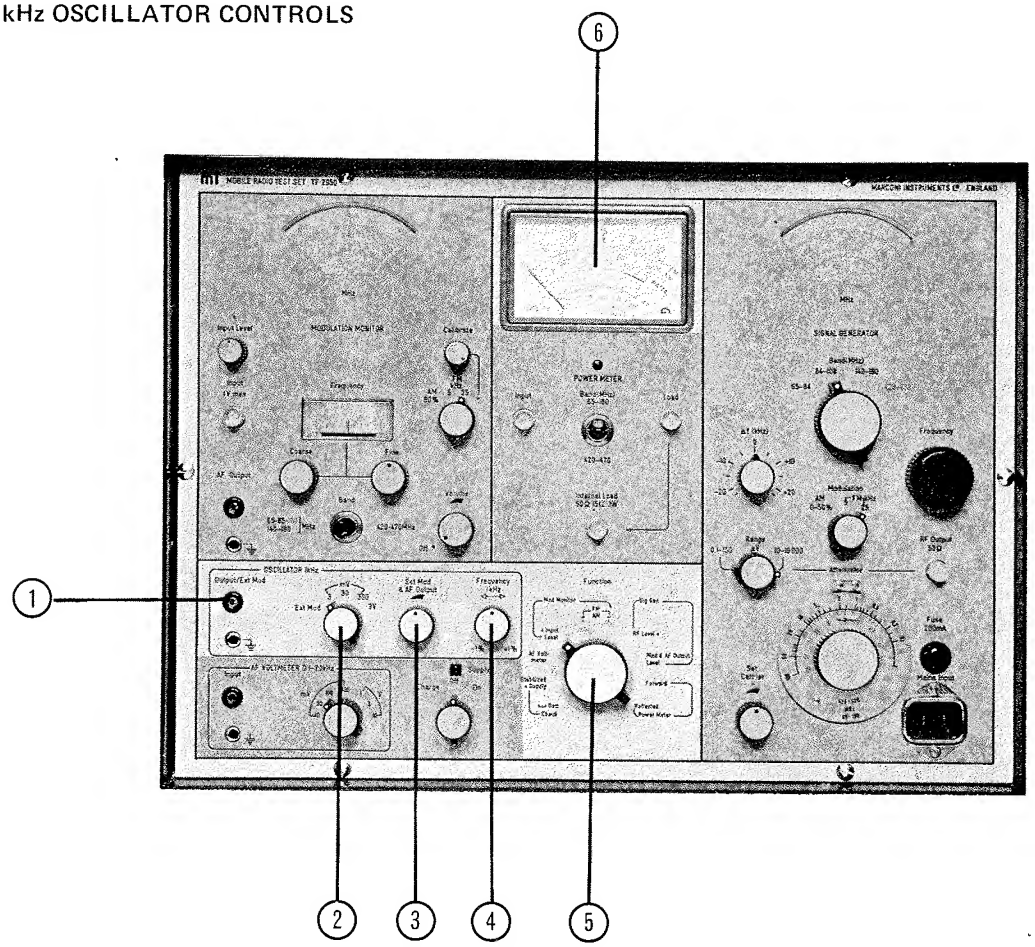
This is a dual purpose unit which comprises a 50 Ω in-line power meter and a separate 15 W 50 Ω r.f. load. This arrangement allows either in-line or Absorption type measurements to be made.

To bring the Power Meter into operation the FUNCTION SWITCH is set to the power meter mode. (Either Forward or Reflected position).

For in-line measurements the power to be measured is fed into the INPUT socket. The output is taken from the LOAD socket and fed to the appropriate load or aerial. Forward and Reflected power can be measured up to a maximum continuous rating of 25 W. As this device is frequency conscious a frequency range switch is provided to select the required frequency range.

When absorption measurements are to be made the LOAD socket of the in-line is connected to the internal 50 Ω load with the supplied cable. The rating of this load is 15 W continuous with up to 25 W for short periods i.e. approx. 3 mins.

2.5 1 kHz OSCILLATOR CONTROLS



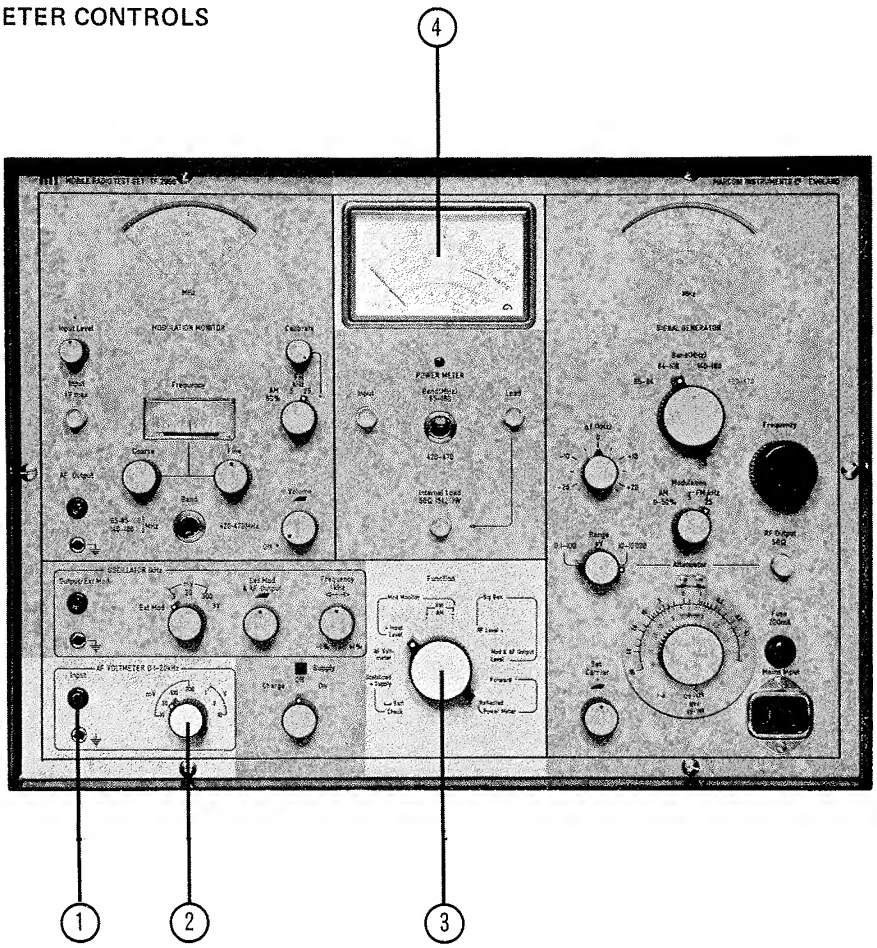
1. Oscillator Output Terminals
2. Oscillator Output Level Range Switch - selects the output level range of the 1 kHz oscillator and also the meter range full scale.
3. Oscillator Output Level Control - sets output level.
4. Oscillator Frequency Control - allows 1 kHz oscillator frequency to be varied by up to ±1%.
5. Function Switch
6. Oscillator Level Indicator

2.5.1 1 kHz Oscillator Operation

With the FUNCTION SWITCH set to the MOD AND A.F. OUTPUT LEVEL position the 1 kHz signal is available at the OUTPUT TERMINALS. The voltage range and monitor full scale is selected by means of the OUTPUT LEVEL RANGE SWITCH. Once the voltage range has been selected the output level can be adjusted with the OUTPUT LEVEL CONTROL, and it is indicated on the test set meter.

The Output Impedance of the oscillator is 200 Ω on the 3 V full scale range and 40 Ω on all other ranges.

2.6 A.F. VOLTMETER CONTROLS



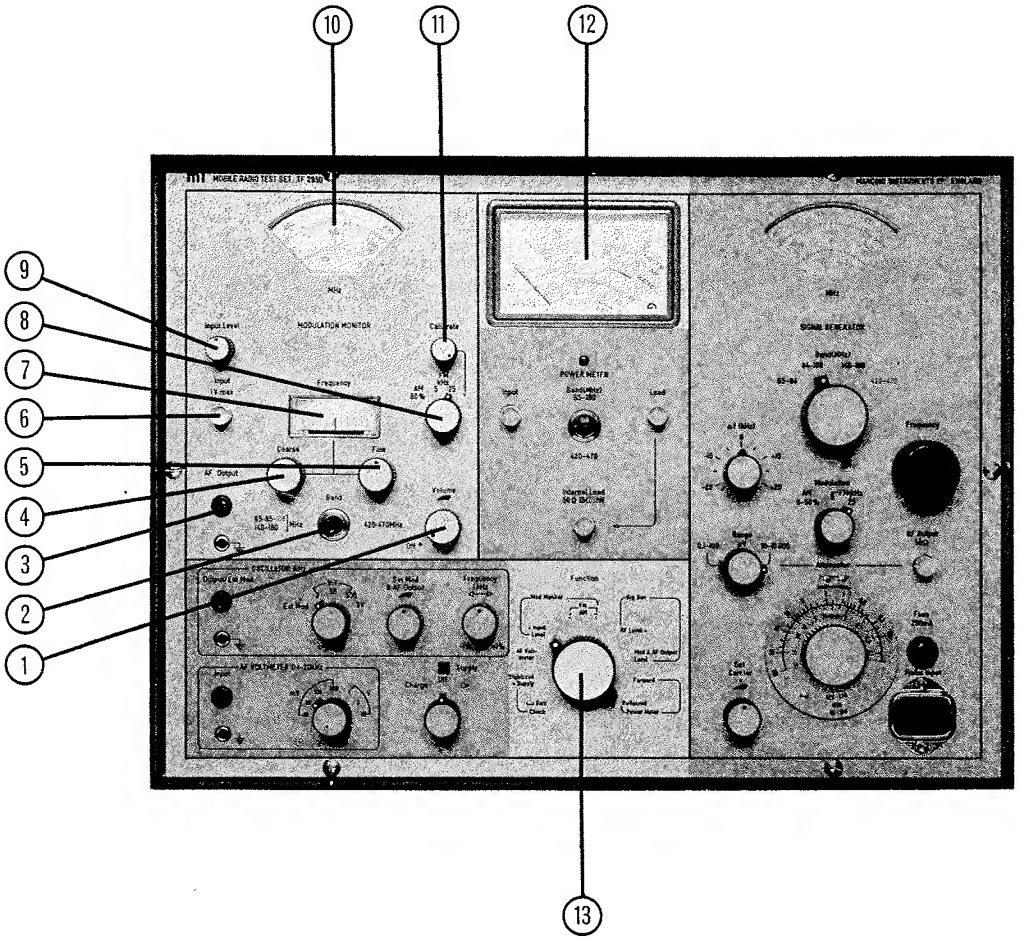
1. Voltmeter Input Terminals
2. Voltmeter Range Switch - Selects ranges of 10 mV, 30 mV, 100 mV, 300 mV, 1 volt, 3 volt and 10 volt f.s.d.
3. Function Switch
4. Voltage Monitor

2.6.1 A.F. Voltmeter Operation

When the FUNCTION SWITCH is set to the A.F. Voltmeter position and the required range selected the signal to be measured is fed to the INPUT terminals. The meter will indicate the level of the input signal.

The input impedance of the voltmeter is 100 kΩ and the frequency range is 100 Hz to 20 kHz.

2.7 MODULATION MONITOR CONTROLS



1.	Loudspeaker ON/OFF Switch and Volume Control	-	switches loudspeaker into circuit and adjusts volume of audio signal.
2.	Input Frequency Range Switch		
3.	A.F. Output Terminals	-	The demodulated output is available at these terminals for analysis.
4.	Coarse Frequency Control	-	Coarse adjustments of local oscillator frequency.
5.	Fine Frequency Control		
6.	R.F. Input Socket	-	50 Ω B.N.C. Socket.
7.	Local Oscillator Tuning Indicator	-	Indicates when I.F. is at correct value.
8.	Modulation Range Switch	-	Selects full scale indication of monitor circuit.
9.	R.F. Input Level Control	-	Adjusts r.f. input level to required value.
10.	Local Oscillator Frequency Dial	-	Indicates frequency to which local oscillator is set.

11. Calibrator Control - Adjusts accuracy of monitor.

12. Meter - Indicates percentage modulation depth and peak frequency deviation. Also used to indicate r.f. input level and modulation level.

13. Function Switch

2.7.1 Modulation Monitor Operation

Before the modulation monitor is used for any measurements it is advisable to check and adjust the calibration accuracy of the unit. An internal calibration signal is provided for this purpose. In order to bring it into operation the FUNCTION SWITCH should be set to the modulation monitor FM/AM position. When the MODULATION RANGE SWITCH is set to the CALIBRATE position the CALIBRATOR CONTROL* can be used to bring the meter indication to the RED DOT. This sets the accuracy of the monitor. Care must be taken to ensure that the loudspeaker volume control is in the OFF position, i.e. anti-clockwise.

*When using the CALIBRATE control the 1 kHz oscillator must not be switched to the EXT. MOD. position.

F.M. MEASUREMENTS

The modulation monitor INPUT LEVEL position must be selected with the FUNCTION SWITCH. The signal to be measured is then fed into the R.F. INPUT SOCKET. (The level required is between 5 mV and 1 V into 50 Ω). The MODULATION RANGE SWITCH is used to select the required deviation range and the INPUT FREQUENCY RANGE SWITCH to select the local oscillator frequency coverage.

Using the COARSE LOCAL OSCILLATOR FREQUENCY CONTROL the local oscillator frequency should be set to, approximately that of the input signal. This control should then be tuned slowly to obtain a peak reading on the main meter. The R.F. INPUT LEVEL CONTROL can now be used to bring the main meter indication to the RED DOT.

In order to set the local oscillator for best operation of the modulation meter a separate TUNING INDICATOR is provided. As the frequency of the local oscillator is adjusted this meter will indicate the classical discriminator 'S' curve. i.e. as the correct tuning point is approached the meter will move from its centre indication and rise to a peak. As the frequency of the local oscillator is adjusted further the meter reading will fall and pass through the centre zero point to the other side where it will once more rise to a peak before falling once more to the centre zero position where it will remain until the next tuning point is reached. The correct tuning point is the indication of centre zero which occurs between the two peak readings. Once this has been set the modulation can be indicated.

The FUNCTION SWITCH must now be set to the +FM or -FM position. In the +FM position the peak deviation above the carrier frequency is indicated when the local oscillator is tuned above the frequency of the input signal. In the -FM position the peak deviation below the carrier frequency will be indicated. The sense of the +ve and -ve readings is reversed when the local oscillator is on the 85-108 MHz range.

A.M. MEASUREMENTS

The modulation monitor INPUT LEVEL position must be selected with the FUNCTION SWITCH. The signal to be measured is then fed into the R.F. INPUT SOCKET. (The level required is between 50 mV and 1 V into 50 Ω). The MODULATION RANGE SWITCH is used to select the 80% A.M. DEPTH RANGE and the INPUT FREQUENCY RANGE SWITCH to select the local oscillator frequency coverage.

Using the COARSE LOCAL OSCILLATOR FREQUENCY CONTROL the local oscillator frequency should be set to, approximately that of the input signal. This control should then be tuned slowly to obtain a peak reading on the main meter. The R.F. INPUT LEVEL CONTROL can now be used to bring the main meter indication to the RED DOT.

Now set FUNCTION SWITCH to either the +AM or -AM position. The +AM position of the FUNCTION SWITCH will give an indication of the peak modulation depth as measured at the peak of the modulation envelope, whereas the -AM position will give an indication of the peak modulation depth as measured in the trough of the modulation envelope.

A demodulated sample of any modulation signal is available at the A.F. output terminals where it can be used for distortion measurements, spurious noise modulation measurements etc.

An audible indication of the modulation is also available from the loudspeaker mounted on the rear panel of the test set. The LOUDSPEAKER ON/OFF SWITCH AND VOLUME CONTROL is used if this function is required. However some degradation of measurement accuracy can occur with the loudspeaker on and therefore if the most accurate measurements of modulation depth or frequency deviation are required these parameters should be measured before the loudspeaker is switched on.

The r.f. input level range is from 5 mV to 1 V. If the modulation appearing on higher signal levels i.e. above 0.5 W, needs to be measured this signal should be fed into the INPUT socket of the Power Meter. A sample of this signal is fed to the modulation meter to allow measurements to be made.

Chapter 3

Technical description

3.1 POWER SUPPLY (Fig. 3.1 and Fig. 7.2)

The supply voltage, for each of the various units which go to make up TF 2950, is derived directly from the external rechargeable batteries which are of the lead and sulphuric acid type. As such they can function in any position and require no servicing. In order to ensure maximum life and operational readiness it is important not to leave the batteries in an uncharged state and also to ensure that they are not overcharged. To alleviate the latter problem the internal charging circuit is designed to reduce from the full charging rate to the trickle charge rate once the batteries are fully charged.

The mains supply, which is used to produce the battery charging supply, is fed via a split primary transformer to a full-wave rectifier D104. The capacitor C102 is charged via D101 and R101 and the resultant p.d. developed across R101 turns on TR101 and causes LP402 to light. TR102 also switches on and the full charging current is fed to the batteries via R101, D101 and TR102. A constant voltage of 21.5 V, derived by D401, D102 and R109, is fed to the base of TR102. This voltage is adjusted by means of R109 and it therefore determines the voltage at which the full charging rate is reduced to a trickle rate. R101 is used to set the maximum charging current. The full charging rate is only selected when the supply switch is set to the CHARGE position which automatically disconnects any load from the battery.

With the supply switch set to the ON position the internal batteries are charged at a trickle rate when the mains supply is connected. Under these conditions the battery is charged at about 80% of its maximum rate. The operation of TR101 and TR102 is the same as under full CHARGE conditions but the charging voltage is reduced to 19.6 V to prevent excessive gassing of the cells. The value of the charging voltage is set by D401, D103 and R108.

The condition of the internal batteries can be monitored at any time by switching the function switch to the "BATT CHECK" position when the meter should read in the "BATT" arc if the batteries are charged up.

3.2 VOLTAGE STABILISING CIRCUIT (Fig. 3.1 and Fig. 7.2)

The D.C. supply voltage for the various units of the instrument, which is derived from the internal batteries, is fed to the stabiliser circuit in order to maintain the supply rails at a constant 14 V during the discharge cycle of the batteries. Transistor TR104 acts as a conventional Series Voltage Regulator with D105 producing the reference voltage for the control circuit. The reference voltage is fed to the base of TR106 which with TR107 forms a differential amplifier. The output of the Series Regulator appears across the resistor chain of R123, R122 and R121 and a sample is taken from the wiper of R122 and fed to the base of TR107. Any difference between this voltage and that of the D.C. reference is amplified and fed via TR105 back to the Series Regulator. This forms the control loop which provides the voltage stabilisation required. The variable resistor R122 is used to adjust the level of the 14 V line and C105 is to provide any ripple compensation necessary.

In order to protect the Series Regulator from damage that could be caused by an accidental short circuit occurring on the 14 V line, TR108 has been added. If the current drawn from TR104 rises to a dangerous level the potential difference across R117 and R118 will increase to a value sufficient to switch on TR108. This will cause TR104 to be switched off by TR105, thus preventing any damage being caused to TR104.

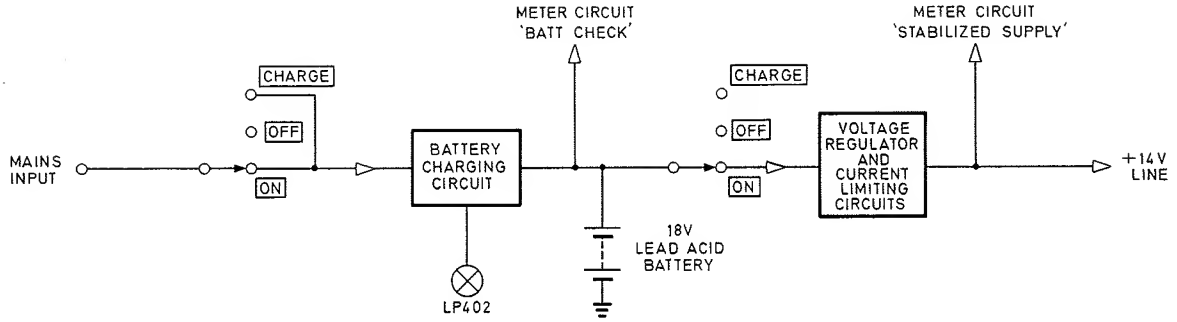


Fig. 3.1 Power Supply Block Diagram

3.3 A/F VOLTMETER (Fig. 3.2 and Fig. 7.2)

To allow small A.C. voltages to be measured in the presence of D.C. voltages up to 250 V the input circuitry is A.C. coupled with C405. The voltmeter input impedances of 100 kΩ is set by the switchable attenuator which allows full scale ranges of 10, 30, 100, 300 mV and also 1, 3 and 10 V to be selected. An 'n' channel f.e.t. is used in the first stage of the voltmeter amplifier to keep the input impedance high. This is directly coupled to the successive stages giving a total gain of 50 dB. Negative feedback, used to keep the response of the amplifier flat and the gain stable, is set by R154. The high frequency response of the amplifier is adjusted by means of C122. TR119 which is connected in a grounded emitter configuration feeds a full wave rectifier D109, D110, D111 and D112. The resultant D.C. signal is fed via the calibration resistor RV163 to the meter for monitoring purposes.

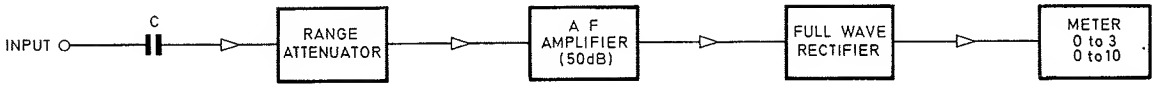


Fig. 3.2 A/F Voltmeter Block Diagram

3.4 1 kHz A/F OSCILLATOR (Fig. 3.3 and Fig. 7.2)

The circuit used for the 1 kHz oscillator is that of an R.C. Wien Bridge. The frequency determining components R128, R129, R130, R414, C109 and C110 are arranged in a series/parallel configuration. R128 is used to set the nominal frequency of the oscillator to 1 kHz while the variable resistor R414 is the front panel control which allows the nominal 1 kHz to be adjusted by ±1%.

The transistors TR110, TR111 and TR112 are connected as a directly coupled amplifier with the feedback taken from the output of TR112 via R137 which can be adjusted to set the feedback for optimum operation. Amplitude stabilisation is achieved by means of LP401 which is connected in the emitter of TR110 where it acts as a voltage controlled resistance varying in sympathy with the feedback voltage across it. This varies the gain of TR110 and hence the amplitude of the oscillator circuit output.

From the collector of TR112 the oscillator signal is fed into the output stage comprising TR113, TR114 and TR115. Negative feedback is taken from the complementary output stage at the junction of R146 and R147 and fed to the base of TR113 via resistors R140 and R141. The optimum working point for TR113 is set by means of R140 while R139 is used to set the level of the input signal to the output amplifier.

Control of the output level is achieved by means of the SET A.F. Output and Mod. Level control R412 in conjunction with the output range attenuator. The input to the attenuator is monitored by D402 and the resultant D.C. signal fed via the calibration control R432 to the meter.

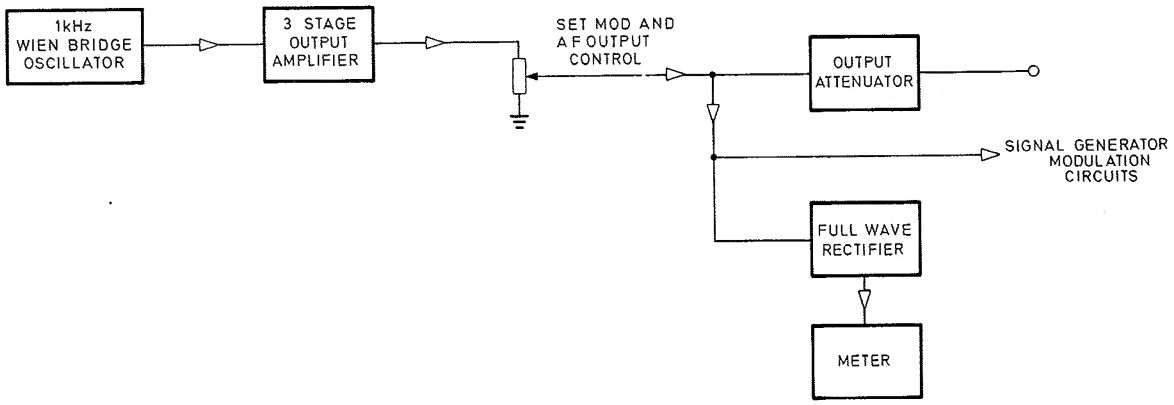


Fig. 3.3 A/F Oscillator Block Diagram

3.5 MODULATION MONITOR (Fig. 3.4 and Fig. 7.3)

The modulation monitor has the capability of measuring both peak frequency deviation and amplitude modulation depth. The standard receiver technique of mixing the input signal with that of a local oscillator to produce a fixed intermediate frequency of 10.7 MHz is used. All measurements of FM and AM are then carried out at the I.F., although due to conflicting requirements a separate I.F. amplifier is used for each type of modulation.

The local oscillator has two ranges, one covering 74 to 98 MHz and the other 214 to 241 MHz. The appropriate oscillator range is selected by switching the oscillator transistor D.C. supply. With an input frequency of 65-85 MHz the local oscillator is tuned over the range of 75.7 MHz to 95.7 MHz thus producing a difference frequency of 10.7 MHz.

When the input frequency is between 85 and 108 MHz the local oscillator is tuned over the range of 74.3 to 97.3 MHz, again producing an I.F. of 10.7 MHz. For the 140-180 MHz input range the second harmonic of the basic 74 to 98 MHz oscillator is used.

In the case of the U.H.F. band of 420-470 MHz the second harmonic of the 214-241 MHz oscillator is used.

Both oscillators are connected in the Colpitts configuration with the tuning achieved by means of the variable capacity diodes D212 and D213. The variable resistors R271 and R443 are the main tuning and fine tuning controls respectively. R271 is mechanically coupled to the modulation monitor frequency dial which is calibrated directly in input frequency. The output from each oscillator is fed to the diode mixer D209 via the buffer amplifier. TR215 which eliminates any frequency pulling that may occur between the local oscillator and input signal.

Under normal conditions the input signal is fed into the mixer via the modulation monitor RF input socket SK405. However, should the signal to be measured exceed about 500 mW it can be connected to the power meter load. A small sample of the signal is then capacitively coupled to the modulation monitor input socket by means of capacitor C213.

The output from the mixer is fed via a bandpass filter, which is used to reduce the level of unwanted signals, to the appropriate I.F. amplifier. Only the I.F. amplifier in use has the D.C. supply connected by means of the AM/FM range switch.

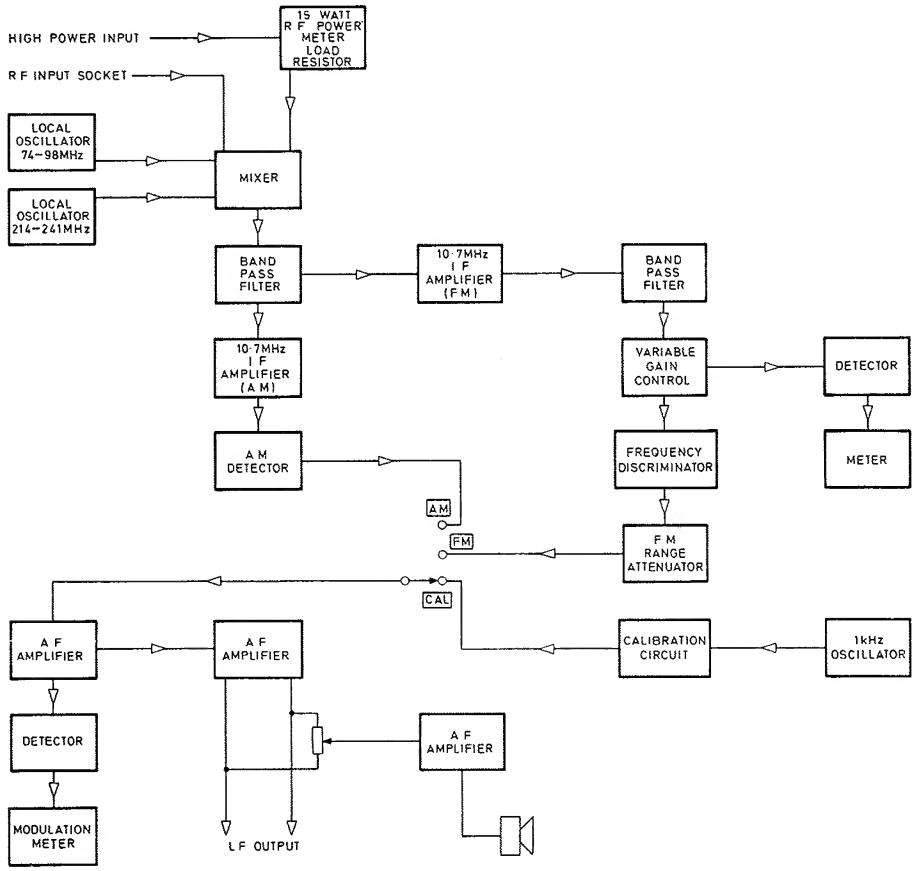


Fig. 3.4 Block Diagram of the Modulation Monitor

3.5.1 F.M. Circuitry

The output from the bandpass filter L201, C215 and C216 is fed into the integrated circuit I.F. amplifier I.C.207. This increases the level of the I.F. signal and also reduces any spurious A.M. on the F.M. signal by conventional limiter action. The I.F. amplifier is followed by another bandpass filter comprising L202, C219 and C220 and a variable gain amplifier TR208. The range of control is 40 dB and is obtained by means of R441 which is the R.F. Input Level control. This sets the gain of the amplifier according to the level of the signal at the r.f. input socket. In order to have an indication when the input level is correct a sample of the output from TR208 is rectified by D208 and fed to the instrument's meter. The Input Level control R441 is then adjusted until the meter reads on the calibration mark once the local oscillator has been set to the correct frequency.

Demodulation of the F.M. signal is achieved by means of the Foster Sealey discriminator following TR208. The average D.C. signal appearing at the output of the discriminator is monitored by meter M402 to provide an indication of when the I.F. signal is tuned to the centre of the discriminator characteristic.

The demodulated audio signal is then fed via the deviation range attenuator to the A.F. amplifier section. Here it is amplified by TR201, TR202 and TR203 which are arranged as an R.C. amplifier with an f.e.t. input stage. Negative feedback, via R205 and C203, is used to maintain the gain and frequency response of the amplifier constant. The output from TR203 is fed to a pair of diodes which provide the meter signal for the positive and negative indication depending on the position of the Function Switch. D201 gives the signal equivalent to the positive deviation and D202 the signal for the negative deviation. (Note that on the input range of 85-108 MHz the position of the positive and negative deviation indication is reversed because the local oscillator frequency is below that of the input signal).

From TR202 the signal is fed to TR204 which produces the audio output available at SK405 and this can be used for analysis purposes. An I.C. amplifier IC205 is used to raise the level of the audio signal to a sufficiently high level to drive a small loudspeaker which gives an audible indication of the demodulated signal.

A calibration signal, that is derived from the internal 1 kHz oscillator, is provided so that the gain of the audio section can be checked periodically and adjusted by means of R209 the f.m. calibrate control.

3.5.2 A.M. Circuitry

The output from the bandpass filter following the mixer is also fed to the A.M. I.F. amplifier comprising TR210 and TR211. The amplifier is only switched on when A.M. measurements are being made. During F.M. measurements it is switched off to eliminate the possibility of interference. The gain of the first stage can be varied over a range of 40 dB by R441 the r.f. Input Level control. After amplification the signal is fed to the diode demodulator D210. The d.c. output is fed to the meter via the set r.f. level (A.M.) preset R255 to give an indication of when the r.f. input level is correct.

The demodulated audio signal is fed into the A.F. amplifier, via the calibration resistor R257, where it undergoes a similar process to the F.M. demodulated signal. In the case of A.M. the diodes D201 and D202 provide the Peak and Trough modulation depth readings on all ranges.

3.6 SIGNAL GENERATOR (Fig. 3.5 and Fig. 7.4)

The oscillator circuit for each of the V.H.F. ranges is arranged in a Colpitts configuration with TR304 as the active element. Frequency range change is achieved by means of switching oscillator coils with the frequency range selector switch. Variation of the frequency across each band is obtained by means of the variable capacitor C344. This component has been produced by milling it from a solid block of metal which makes it very rigid and reduces any microphonic effects to a minimum.

A varicap diode, D301, provides both frequency modulation and electrical fine tuning facilities. It is coupled into the oscillator circuit with either C345 or C356 depending on the R.F. range. To maintain a constant F.M. deviation sensitivity over each R.F. band the variable potentiometer R326 is mechanically coupled to the main frequency drive. The modulation signal is fed via R326 to D301 and this has the result of reducing the modulation drive level as the carrier frequency is increased thus compensating for the increase in F.M. sensitivity.

Adjustment to the F.M. sensitivity on each R.F. range is made by means of R347, R348 and R349 while, R428 sets up the F.M. deviation on all bands. The F.M. deviation range switch allows ranges of 0-5 kHz or 0-25 kHz peak deviation to be selected. Variation of the D.C. bias across D301 with R410 produces the calibrated fine tuning facility of $\pm$20 kHz on each range.

From the oscillator the signal is fed to TR301 which is a variable gain wideband amplifier. This is used to adjust the level of the R.F. signal by means of the Set Carrier control R407.

Amplitude modulation of the V.H.F. oscillator output is produced by varying the gain of the following amplifier stage TR302 with the audio modulation signal. Internal modulation is at a 1 kHz rate and this is derived from the audio oscillator and fed to TR302 via the calibration resistor R426. The signal is then fed via the buffer amplifier TR303 and the bandpass filter F301 to the output level controls. These consist of a switchable 40 dB pad (the voltage range switch) and a continuously variable 60 dB attenuator. Collectively these controls vary the output level over the range of 0.1 μV to 10 mV from an impedance of 50 Ω.

The U.H.F. band is obtained in a different manner to that used on the V.H.F. ranges. Instead of a fundamental oscillator this band uses a low frequency variable oscillator covering the range of 140-157 MHz followed by a tuned frequency tripler. The oscillator, which is connected in a Colpitts configuration is tuned by C344. On the other hand the frequency tripler is tuned by means of the variable capacity diode D303. The tuning voltage for D303 is taken from the potentiometer R326.

Frequency modulation and electrical fine tuning are carried out on the oscillator with D302 which is coupled into the tuned circuit by C346. This serves as an adjustment for the deviation.

The output from the frequency tripler is fed into the bandpass filter F301 and then to the output range switch and variable attenuator. The input to the attenuator is monitored by D304 and fed to the meter to provide the carrier level indication.

As the signal generator is used for testing high sensitivity receivers, all r.f. circuitry is contained within a screened r.f. box to reduce the spurious radiation to a minimum. All signals fed into the r.f. unit are fed in via r.f. filters for the same reason.

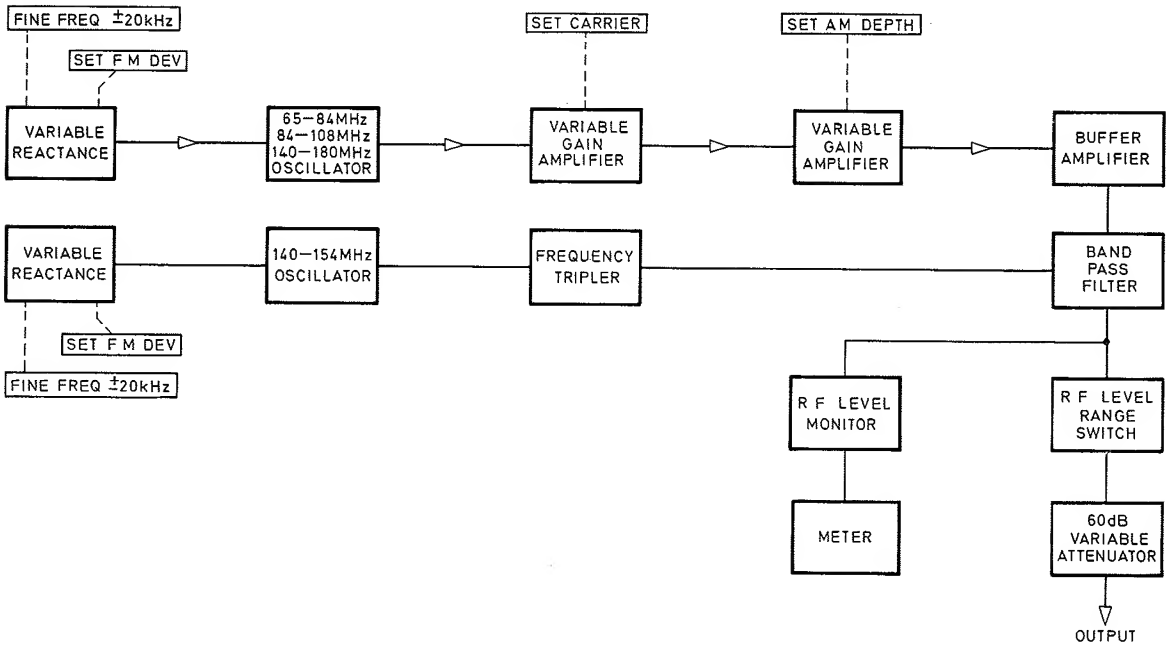


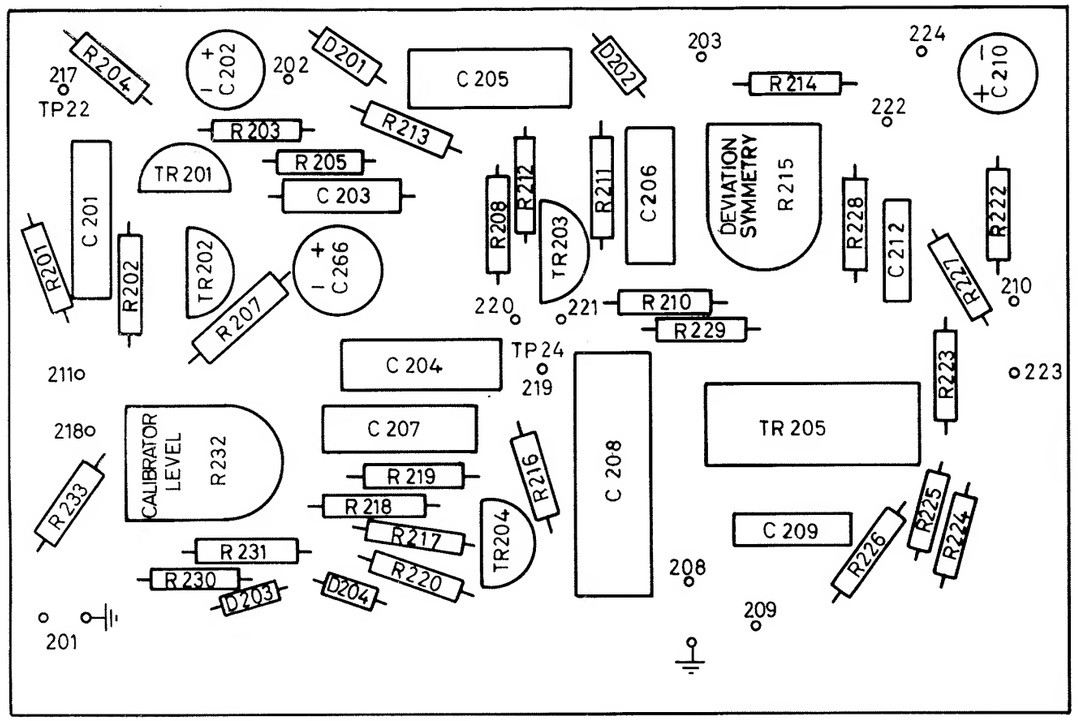
Fig. 3.5 Signal Generator Block Diagram

3.7 R.F. POWER METER

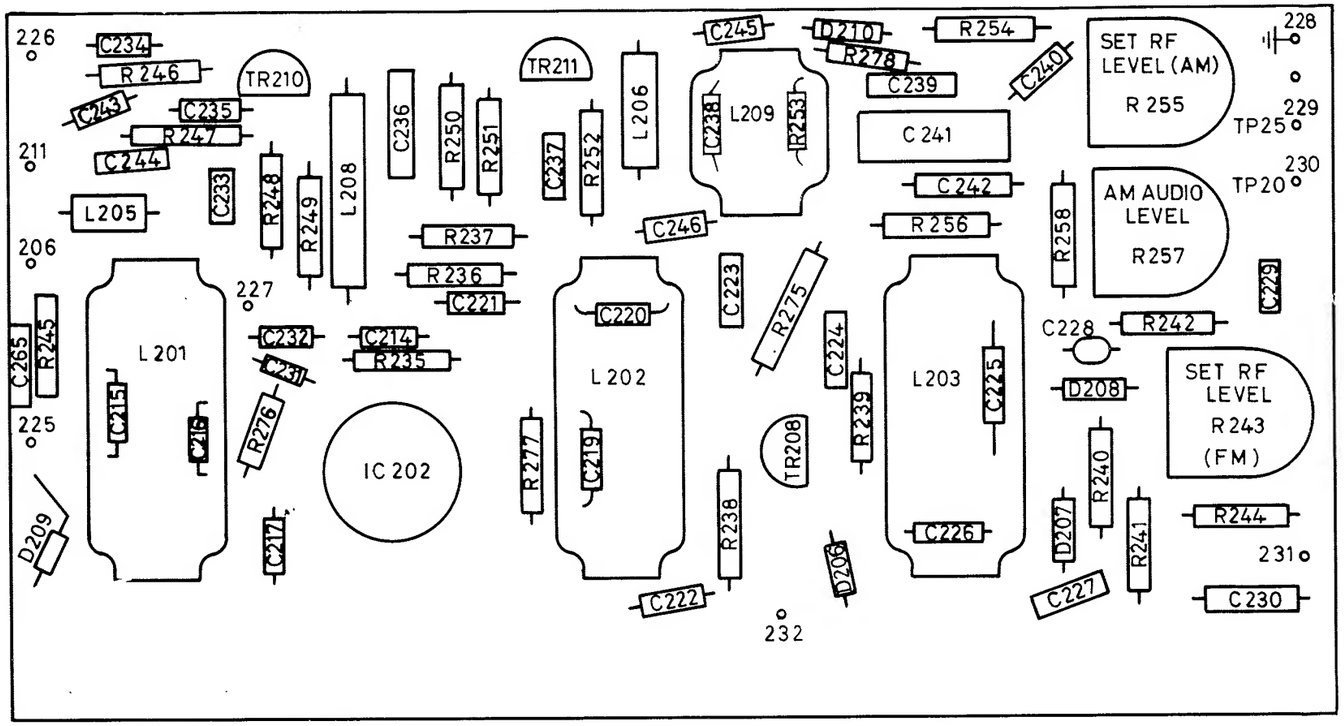
This unit works on the in-line principle. The basis of operation is the mutual inductance existing between the inductive sensing elements and the centre conductor of a short length of air spaced transmission line having a 50 Ω characteristic impedance. Four inductors are arranged around the centre conductor, two for each R.F. range. One gives indication of the forward power and the other one of each pair gives the signal for the reflected power reading.

The output from each of the sensing elements L501, L502, L503 and L504 is proportioned to the directional power flowing through the power meter. A separate r.f. load resistor R519 is provided so that either in-line or absorption type power measurements can be made.

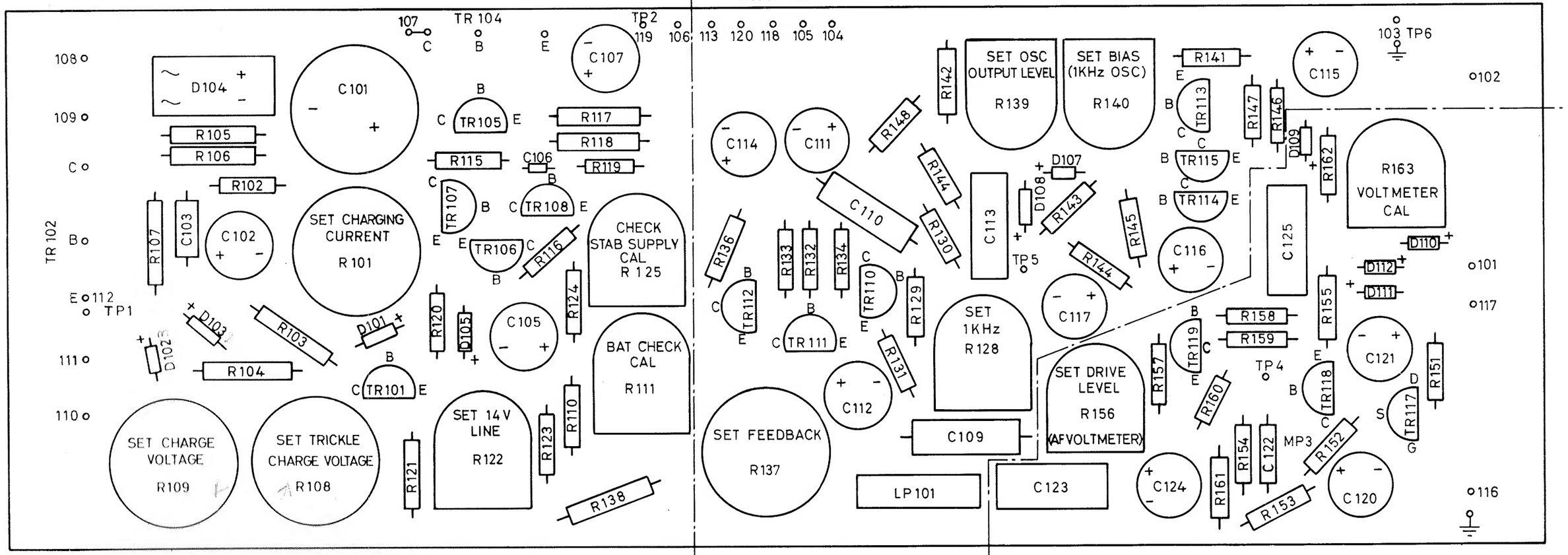
A calibration resistor is provided for each of the directional couplers so that the power meter indication can be adjusted.



MODULATION MONITOR AUDIO AMPLIFIER



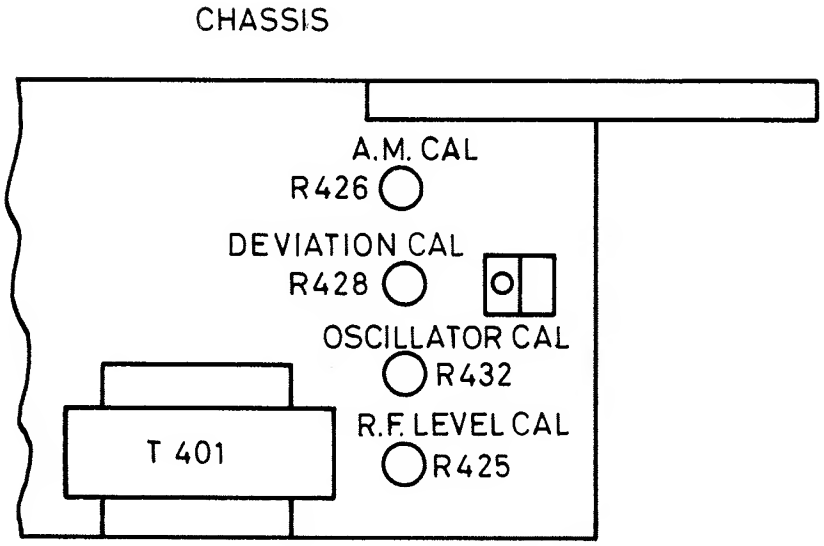
FM IF AMP AND DISCRIMINATOR
AM IF AMP AND DEMODULATOR



POWER SUPPLY AND VOLTAGE STABILISER AUDIO OSC AF VOLTMETER

Fig. 5.1 P.C.B. Component Layout

Maritime Electronic A/S
Anne Grimdalensv. 1
4000 Stavanger
Tlf. 045 / 24500



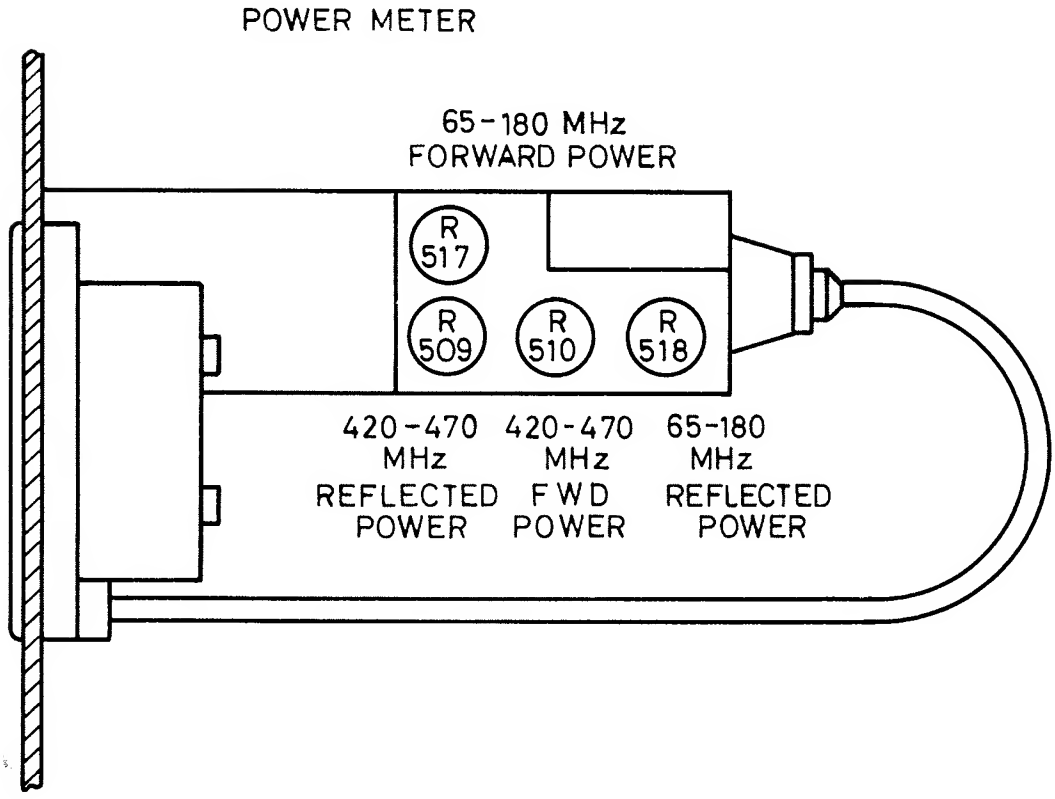


Fig. 5.2 Location of Preset Controls

Chapter 6

Replaceable parts

6.1 INTRODUCTION

This chapter lists the replaceable parts in alphanumerical order of circuit references, sub-divided into eleven sections in the order shown below. The associated circuit diagrams are also indicated.

Battery Charging Unit	-	Fig. 7.2
Stabilised Power Supply	-	Fig. 7.2
A.F. 1 kHz Oscillator and Final Stage	-	Fig. 7.2
A.F. Voltmeter	-	Fig. 7.2
Modulation Monitor - A.F. Amplifier	-	Fig. 7.3
Modulation Monitor - F.M.-I.F. Amplifier	-	Fig. 7.3
Modulation Monitor - A.M.-I.F. Amplifier (10.7 MHz)	-	Fig. 7.3
Modulation Monitor - Oscillator	-	Fig. 7.3
Signal Generator - Oscillator	-	Fig. 7.4
Main Chassis Assembly	-	Fig. 7.1
R.F. Power Meter	-	Fig. 7.5

The following abbreviations are used in the parts list -

B	Battery	Met	Metal
C	Capacitor	Plas.	Plastic
Carb.	Carbon	R	Resistor
Cer	Ceramic	Rect.	Rectifier
D	Diode	S	Swtich
Elect.	Electrolytic	Selen	Selenium
FL	Filter	SK	Socket
FS	Fuse	Styro	Styroflex
IC	Integrated Circuit	T	Transformer
L	Inductor	TR	Transistor
LP	Lamp	Var	Variable
LS	Loudspeaker	W.W.	Wire Wound
M	Meter		

6.2 ORDERING

When ordering replacement or spare parts, address the order to our Service Division (for address see rear cover) or nearest representative. Please specify the following information for each part required.

(i) Type and serial number of instrument (see rear data plate)

(ii) Circuit reference number

(iii) Description

(iv) M.I. part number (preceded by FPP)

If a part is not listed, state its function, location and description when ordering.

Spares supplied against M.I. part numbers are electrically interchangeable with those originally fitted, but may not always be identical.

6.3 PARTS LIST

Circuit Reference	Description	M.I. Code No. FPP/
BATTERY CHARGING UNIT		
Capacitors -		
C101	Elect. 500 µF 35 V	50-6500-0035
C102	Elect. 50 µF 35 V	50-6050-0035
C103	Styro. 220 pF 100 V	46-2220-0100
Diodes -		
D101	Silicon Diode EC401	71-3300-0401
D102	Zener Diode BZY85C13	72-2211-1013
D103	Zener Diode BZY85C15	72-2211-1015
D104	Selen. Rect. B30C 450/400	74-2300-1450
Resistors -		
R101	Var. W.W. 100 Ω 1W	15-2100-1151
R102	Carb. Film 18 kΩ ± 5% 1/8W	11-4018-1851
R103	Carb. Film 470 Ω ± 5% 1/2W	11-2470-1251
R104	Carb. Film 1.5 kΩ ± 5% 1/2W	11-3015-1251
R105	Carb. Film 15 Ω ± 5% 1/3W	11-2015-1351
R106	Carb. Film 15 Ω ± 5% 1/3W	11-2015-1351
R107	Carb. Film 3.3 kΩ ± 5% 1/3W	11-3033-1351
R108/109	Var. W.W. 100 Ω Preset 1W	15-2100-1151
R110	Carb. Film 470 kΩ ± 5% 1/8W	11-4470-1851
R111	Var. Carb. Film 250 kΩ 1/8W	13-4250-1851
R112	Carb. Film 1.2 kΩ ± 5% 1/3W	11-3012-1351
Transistors -		
TR101	Silicon PNP BC212B	82-1110-0212
TR102	Silicon NPN 2N5295	81-2300-5295
STABILISED POWER SUPPLY		
Capacitors -		
C105	Elect. 10 µF 65 V (35 V)	50-6010-0065
C106	Ceramic Disc 1000 pF	43-3010-0400
C107	Elect. 100 µF 15 V	50-6100-0015
Diodes -		
D105	Zener Diode BZY85 C6V8	72-2211-1628
Resistors -		
R115	Carb. Film 33 kΩ ± 5% 1/8W	11-4033-1851
R116	Carb. Film 2.2 kΩ ± 5% 1/8W	11-3022-1851
R117/118	Carb. Film 3.3 kΩ ± 5% 1/8W	11-7033-1851
R119	Carb. Film 680 Ω ± 5% 1/8W	11-2680-1851
R120	Carb. Film 4.7 kΩ ± 5% 1/8W	11-3047-1851

Circuit Reference	Description	M.I. Code No. FPP/
Resistors (Cont)		
R121	Carb. Film 2.7 kΩ ± 5% 1/8W	11-3027-1851
R122	Var. Carb. 1 kΩ Preset 0.15W	13-3010-1851
R123	Carb. Film 3.3 kΩ ± 5% 1/8W	11-3033-1851
R124	Carb. Film 560 kΩ ± 5% 1/8W	11-4560-1851
R125	Carb. Film 250 kΩ Preset 0.15W	13-4250-1851
Transistors -		
TR104	Silicon NPN 2N5295	81-2300-5295
TR105-108	Silicon NPN BC183B	81-1100-0183
A.F. 1 kHz ±1% OSC and FINAL STAGE		
Capacitors -		
C109/110	Styro 6800 pF 100 V	46-3068-0100
C111	Elect. 100 μF 15 V (6 V)	50-6700-0015
C112	Elect. 220 μF 15 V	50-6220-0015
C113	Met. Plas. Foil 0.47 μF 100 V	47-4470-0100
C114	Elect. 100 μF 15 V	50-6100-0015
C115/116	Elect. 10 μF 65 V (35 V)	50-6010-0065
C117	Elect. 100 μF 15 V	50-6100-0015
Diodes -		
D107/108	Silicon Diode BA 164	71-2100-0164
Lamps -		
LP101	Lamp 50 mA 6 V	09-6000-0050
Resistors -		
R128	Var. Carb. 5 kΩ Preset 0.15W	13-3050-1851
R129/130	Met. Film 22 kΩ ± 2% 1/8W	12-4022-1821
R131	Met. Film 470 Ω ± 2% 1/8W	12-2470-1821
R132	Met. Film 6.8 kΩ ± 2% 1/8W	12-3068-1821
R133	Met. Film 1.8 kΩ ± 2% 1/8W	12-3018-1821
R134	Met. Film 120 Ω ± 2% 1/8W	12-2120-1821
R135	Met. Film 560 Ω ± 2% 1/8W	12-2560-1821
R136	Met. Film 180 Ω ± 2% 1/8W	11-2180-1821
R137	Var. W.W. 100 Ω Preset 2W	15-2100-1151
R138	Carb. Film 470 Ω ± 5% 1/2W	11-2470-1251
R139/140	Var. Carb. 10 kΩ 1/4W	11-4010-1451
R141	Carb. Film 10 kΩ ± 5% 1/8W	11-4010-1851
R142/143	Carb. Film 1.5 kΩ ± 5% 1/8W	11-3015-1851
R144/145	Carb. Film 1.2 kΩ ± 5% 1/8W	11-3012-1851
R146/147	Carb. Film 10 Ω ± 5% 1/8W	11-2010-1851
R148	Carb. Film 3.3 Ω ± 5% 1/8W	11-7033-1851
R149	Carb. Film 33 Ω ± 5% 1/4W	11-2033-1451
Transistors -		
TR110/111	Silicon NPN BC183B	81-1110-0183
TR112	Silicon NPN BC232B	81-1110-0232
TR113	Silicon NPN BC183B	81-1110-0183
TR114	Silicon NPN BC232B	81-1110-0232
TR115	Silicon PNP BC231B	82-1110-0231

Circuit Reference	Description	M.I. Code No. FPP/
A.F. VOLTMETER		
Capacitors -		
C120/121	Elect. 100 µF 15 V (6 V)	50-6100-0015
C122	Styro 220 pF 100 V	46-2220-0100
C123	Met. Plas. Foil 1 µF 100 V	47-5010-0100
C124	Elect. 250 µF (220 µF) 15 V (6 V)	50-6250-0015
C125	Met. Plas. Foil 1 µF 100 V	47-5010-0100
Diodes -		
D109-112	Germanium Diode AA 132	70-1100-0132
Resistors -		
R151	Carb. Film 4.7 kΩ ± 5% 1/8W	11-3047-1851
R152	Carb. Film 820 Ω ± 5% 1/8W	11-2820-1851
R153	Carb. Film 1.5 kΩ ± 5% 1/8W	11-3015-1851
R154	Carb. Film 10 kΩ ± 5% 1/8W	11-4010-1851
R155	Carb. Film 560 Ω ± 5% 1/8W	11-2560-1851
R156	Var. Carb. 5 kΩ 0.15W	13-3050-1851
R157	Carb. Film 27 kΩ ± 5% 1/8W	11-4027-1851
R158	Carb. Film 120 kΩ ± 5% 1/8W	11-4120-1851
R159	Carb. Film 1.5 kΩ ± 5% 1/8W	11-3015-1851
R160	Carb. Film 56 Ω ± 5% 1/8W	11-2056-1851
R161	Carb. Film 390 Ω ± 5% 1/8W	11-2390-1851
R162	Carb. Film 39 kΩ ± 5% 1/8W	11-4039-1851
R163	Var. Carb. 10 kΩ 0.15W	13-4010-1851
Transistors -		
TR117	Silicon N channel FET BF256B	83-1210-0256
TR118	Silicon PNP BC212B	82-1110-0212
TR119	Silicon NPN BC232B	81-1110-0232
MODULATION MONITOR A/F AMPLIFIER		
Capacitors -		
C201	Met. Plas. Foil 0.1 µF 250 V	47-4100-0250
C202	Elect. 100 µF 15 V (6 V)	50-6100-0015
C203	220pf Styro ~~750~~ pF 100 V	46-2750-0100
C204-207	Met. Plas. Foil 0.47 µF 100 V	47-4470-0100
C208	Met. Plas. Foil 3.3 µF 100 V	47-5033-0100
C209	Met. Plas. Foil 0.047 µF 250 V	47-4047-0250
C210	Elect. 100 µF 15 V	50-6100-0015
C211	Elect. 500 µF 35 V	50-6500-0035
C212	1000pf Ceramic Disc 1µF 400 V	43-3010-0400
C266	Elect. 100 µF 15 V (6 V)	50-6100-0015
Diodes -		
D201/202	Germanium Diode AA 132	70-1100-0132
D203/204	Zener Diode BZY85 C6V8	72-2211-1628
Integrated Circuits -		
IC201	Integrated Cct. Amplifier PA237	85-6500-0237

Circuit Reference	Description	M.I. Code No. FPP/
Resistors -		
R201	Carb. Film 1 MΩ ± 5% 1/8W	11-5010-1851
R202	Carb. Film 4.7 kΩ ± 5% 1/8W	11-3047-1851
R203	Carb. Film 820 Ω ± 5% 1/8W	11-2820-1851
R204	Carb. Film 1.5 kΩ ± 5% 1/8W	11-3015-1851
R205	Carb. Film 12 kΩ ± 5% 1/8W	11-4012-1851
R207	Carb. Film 560 Ω ± 5% 1/8W	11-2560-1851
R208	Carb. Film 47 kΩ ± 5% 1/8W	11-4047-1851
R209	Var. Carb. Film 50 kΩ 1/4W	20-4050-8103
R210	Carb. Film 39 kΩ ± 5% 1/8W	11-4039-1851
R211	Carb. Film 220 Ω ± 5% 1/8W	11-2220-1851
R212	Carb. Film 560 Ω ± 5% 1/8W	11-2560-1851
R213	Carb. Film 47 kΩ ± 5% 1/8W	11-4047-1851
R214	Carb. Film 39 kΩ ± 5% 1/8W	11-4039-1851
R215	Var. Carb. 10 kΩ Preset 1/8W	13-4010-1851
R216	Carb. Film 56 kΩ ± 5% 1/8W	11-4056-1851
R217	Carb. Film 39 kΩ ± 5% 1/8W	11-4039-1851
R218	Carb. Film 120 kΩ ± 5% 1/8W	11-4120-1851
R219	Carb. Film 680 Ω ± 5% 1/4W	11-2680-1451
R220	Carb. Film 150 Ω ± 5% 1/8W	11-2150-1851
R222	Carb. Film 33 Ω ± 5% 1/4W	11-2033-1451
R223	Carb. Film 220 kΩ ± 5% 1/8W	11-4220-1851
R224	Carb. Film 56 kΩ ± 5% 1/8W	11-4056-1851
R225/226	Carb. Film 100 kΩ ± 5% 1/8W	11-4100-1851
R227	Carb. Film 18 kΩ ± 5% 1/8W	11-4018-1851
R228	Carb. Film 220 kΩ ± 5% 1/8W	11-4220-1851
R229	Carb. Film 68 kΩ ± 5% 1/8W	11-4068-1851
R230	Carb. Film 6.8 kΩ ± 5% 1/8W	11-3068-1851
R231	Carb. Film 100 kΩ ± 5% 1/8W	11-4100-1851
R232	Var. Carb 50 kΩ Preset 1/8W	13-4050-1851
R233	Carb. Film 8.2 kΩ ± 5% 1/8W	11-3082-1851
R280	Metal Film 82 kΩ 1/8W (S.I.C)	12-4082-1821
R281	Metal Film 27 kΩ 1/8W (S.I.C)	12-4027-1821
R282	Carb. Film 56 kΩ 1/8W (S.I.C)	11-4056-1851
R283	Carb. Film 2.2 kΩ ± 5% 1/8W	11-3022-1851
Switches -		
S201	Rotary switch 4 position 6 wafer	61-0604-1201
Transistors -		
TR201	Silicon N channel FET BF245B	83-1210-0245
TR202	Silicon PNP BC212B	82-1110-0212
TR203	Silicon NPN BC232B	81-1110-0232
TR204	Silicon NPN BC183B	81-1110-0183
MODULATION MONITOR F.M. - I.F. AMPLIFIER		
Capacitors -		
C213	Cer. Disc 22 pF 400 V	41-1068-0400
C214	Cer. Disc 22 000 pF 63 V	43-4022-0063
C215/216	Styro flex 100 pF 63 V	46-2100-0063

Circuit Reference	Description	M.I. Code No. FPP/
Capacitors (cont)		
C217	Cer. Disc 22 000 pF 63 V	43-4022-0063
C219/220	Styro flex 100 pF 63 V	46-2100-0063
C221-223	Cer. Disc 22 000 pF 63 V	43-4022-0063
C224	Cer. Tubular 47 pF 400 V	42-2047-0400
C225/226	Styro flex 50 pF 63 V	46-2050-0063
C227	Cer. Tubular 47 pF 400 V	42-2047-0400
C228	Cer. Disc 3.3 pF 400 V	41-1033-0400
C229	Cer. Disc 1000 pF 400 V	43-3010-0400
C230	Styro flex 100 pF 63 V	46-2100-0063
C231	Cer. Disc 1000 pF 400 V	43-3010-0400
C232	Cer. Disc 22 000 pF 63 V	43-4022-0063
C265	Cer. Tubular 18 pF 100 V	42-2018-0100
Diodes -		
D206-209	Germanium Diode AA138	70-1100-0138
Integrated Circuits -		
IC202	Integrated Cct. Amp CA3053 3043	85-5500-3053
Inductors -		
L201	Input Coil 10.7 MHz	07-2300-1400
L202	Intermediate Tuned cct 10.7 MHz	07-2400-1400
L203	Discriminator Tuned cct 10.7 MHz	07-2500-1400
Resistors -		
R234	Carb. Film 68 Ω ± 5% 1/4W	11-2068-1451
R235	Carb. Film 220 Ω ± 5% 1/2W	11-2220-1251
R236	Carb. Film 68 kΩ ± 5% 1/8W	11-4068-1851
R237	Carb. Film 10 kΩ ± 5% 1/8W	11-4010-1851
R238	Carb. Film 820 Ω ± 5% 1/8W	11-2820-1851
R239	Carb. Film 560 Ω ± 5% 1/8W	11-2560-1851
R240/241	Carb. Film 47 kΩ ± 5% 1/8W	11-4047-1851
R242	Carb. Film 82 kΩ ± 5% 1/8W	11-4082-1851
R243	Var. Carb. 50 kΩ 1/8W	13-4050-1851
R244	270 Carb. Film ~~10~~ kΩ ± 5% 1/8W	11-4010-1851
R245	Carb. Film 1 kΩ ± 5% 1/8W	11-3010-1851
R275	Carb. Film 100 Ω ± 5% 1/8W	11-2100-1851
R276/277	Carb. Film 15 kΩ ± 5% 1/8W	11-4015-1851
Transistors -		
TR208	Silicon NPN BF311	81-120-0311
MODULATION MONITOR		
A.M. I.F. AMPLIFIER 10.7 MHz		
Capacitors -		
C233	Cer. Disc 1000 pF 400 V	43-3010-0400
C234/235	Cer. Disc 22 000 pF 63 V	43-4022-0063
C236	Cer. Tubular 68 pF 400 V	42-4068-0400
C237	Cer. Disc 22 000 pF 63 V	43-4022-0063
C238	Cer. Tubular ~~100~~ 27 pF 400 V	42-2027-0400
C239	Cer. Tubular 56 pF 400 V	42-2056-0400
C240	Cer. Disc 22 000 pF 63 V	43-4022-0063

Circuit Reference	Description	M.I. Code No. FPP/
Capacitors (cont)		
C241	Met. Plas. Foil 0.1 µF 250 V	47-4100-0250
C242	Styro 100 pF 100 V	46-2100-0100
C243-246	Cer. Disc 22 000 pF 63 V	43-4022-0063
C245	— " — 0.1µF 63 V	
Diodes -		
D210	Germanium Diode AA138	70-1100-0138
Inductors -		
L205/206	Ferrite Cored Choke 6 µH	07-2000-1400
L208	Choke 25 µH	07-2100-1400
L209	Tuned Circuit 10.7 MHz	07-2200-1400
Resistors -		
R246	Carb. Film 1 kΩ ± 5% 1/8W	11-3010-1851
R247	Carb. Film 680 Ω ± 5% 1/8W	11-2680-1851
R248	Carb. Film 3.9 kΩ ± 5% 1/8W	11-3039-1851
R249 820Ω	Carb. Film 1.5 kΩ ± 5% 1/8W	11-3015-1851
R250	Carb. Film 4.7 kΩ ± 5% 1/8W	11-3047-1851
R251	Carb. Film 5.6 kΩ ± 5% 1/8W	11-3056-1851
R252	Carb. Film 680 Ω ± 5% 1/8W	11-2680-1851
R253	Carb. Film 1.8 kΩ ± 5% 1/8W	11-3018-1851
R254	Carb. Film 27 kΩ ± 5% 1/8W	11-4027-1851
R255	Var. Carb. 10 kΩ 1/8W Preset	13-4010-1851
R256 68K	Carb. Film 33 kΩ ± 5% 1/8W	11-4033-1851
R257	Var. Carb. 50 kΩ 1/8W Preset	13-4050-1851
R258	Carb. Film 15 kΩ ± 5% 1/8W	11-4015-1851
R278	Carb. Film 8.2 kΩ ± 5% 1/8W	11-3082-1851
Transistors -		
TR210	Silicon NPN BF196	81-1200-0196
TR211	Silicon NPN BF197	81-1200-0197
MODULATION MONITOR OSCILLATOR		
Capacitors -		
C250	Cer. Tubular 15 pF 400 V	42-2015-0400
C251	Cer. Disc 3.3 pF 400 V	41-1033-0400
C252	Cer. Tubular 39 pF (S.I.C) 400 V	42-2039-0400
C253-254	Cer. Disc 0.6 pF 400 V	41-1006-0400
C255	Cer. Disc 6.8 pF 400 V	41-1068-0400
C256	Cer. Disc 3.3 pF 400 V	41-1033-0400
C257	Cer. Tubular 15 pF 400 V	42-2015-0400
C258-262	Feed thro' 1000 pF 400 V	49-3010-0400
C263	Cer. Tubular 18 pF 400 V	42-2018-0400
Diodes -		
D212-213	Varactor BB105	73-2400-0105
Inductors -		
L210	Coil (9 turns, 1 mm silver wire on 6 mm former)	07-1600-2000
L211	Coil (3 turns, 1 mm silver wire on 6 mm former)	07-1700-2000

Circuit Reference		Description	M.I. Code No. FPP/
Resistors -			
R262		Carb. Film 390 Ω ± 5% 1/8W	11-2390-1851
R263-264		Carb. Film 8.2 kΩ ± 5% 1/8W	11-3082-1851
R265		Carb. Film 390 Ω ± 5% 1/8W	11-2390-1851
R266		Carb. Film 1.5 kΩ ± 5% 1/8W	11-3015-1851
R267		Carb. Film 5.6 kΩ ± 5% 1/8W	11-3056-1851
R268-269		Carb. Film 150 Ω ± 5% 1/8W	11-2150-1851
R270	1k	Carb. Film 820 Ω ± 5% 1/8W	11-2820-1851
R271		Var. Carb. Film 10 kΩ 1/2W	21-4010-1201
Transistors -			
TR213		Silicon N channel FET BF256B	83-1210-0256
TR214		Silicon N channel FET BF256B	83-1210-0256
TR215		Silicon NPN TIS18	81-4400-0018
SIGNAL GENERATOR OSCILLATOR			
Capacitors -			
C301-303		disc 22000pf Cer. Feed thro' 1000 pF 400 V	49-3010-0400
C304		Cer. Disc 1000 pF 400 V	43-3010-0400
C305	1μF	Met. Plast. Foil 0.47 μF 100 V	47-4470-0100
~~C306-309~~		Cer. Feed thro' 1000 pF 400 V	49-3010-0400
~~C310~~		Cer. Tubular 47 pF 400 V	42-2047-0400
C311		Cer. Disc 1000 pF 400 V	43-3010-0400
C315		Cer. Feed thro' 4700 pF 400 V	48-3047-0400
C316 - 317		Cer. Feed thro' 1000 pF 400 V	43-3010-0400
C318		Cer. Feed thro' 4700 pF 400 V	48-3047-0400
C319-320		Cer. Feed thro' 1000 pF 400 V	43-3010-0400
C321		Cer. Feed thro' 4700 pF 400 V	48-3047-0400
C322-326		Cer. Feed thro' 1000 pF 400 V	43-3010-0400
C327-328		Cer. Feed thro' 4700 pF 400 V	48-3047-0400
C329-338		Cer. Feed thro' 1000 pF 400 V	43-3010-0400
C339		Cer. Tubular 15 pF 400 V	42-2015-0400
C340		Cer. Disc 3.9 pF 400 V	41-1039-0400
C341		Cer. Disc 2.2 pF 400 V	41-1022-0400
C342-343		Cer. Tubular 1000 pF 400 V	44-3010-0400
C344		Var. Neuwirth 2-12 pF	08-2000-0012
C345-346		Trimmer Neuwirth 0.3 - 1 pF	08-3000-0001
C347		Cer. Disc 3.9 pF 400 V	41-1039-0400
C348		Cer. Tubular 15 pF 400 V	42-2015-0400
C349		Cer. Disc 5.6 pF 400 V	41-1056-0400
C350		Cer. Disc (SIC) 2.2 pF 400 V	41-1022-0400
C351		Trimmer Tubular 0.6 - 6 pF	07-3600-1500
C352		Cer. Disc 5.6 pF 400 V	41-1056-0400
C353		Cer. Disc 5.6 6.8 pF 400 V	41-1068-0400
C354-355		Cer. Disc 1000 pF 400 V	43-3010-0400
C356		Trimmer Neuwirth 0.3 - 1 pF	08-3000-0001
C357/358		Cer disc . 22,000pf 63V	
Diodes -			
D301		Varactor BB105	73-2400-0105
D302		Varactor BB105	73-2400-0105
D303		Varactor BB105	73-2400-0105
D304		Germanium Diode AA138	70-1100-0138
C359		tantal 47μf/63V	
C306		Cer disc 1000pf/400V	
C307-309		Cer disc 22000 pf/400V	

Circuit Reference	Description	M.I. Code No. FPP/
Filter -		
FL301	Aerial Filter "Hirschmann"	07-1100-2100
Inductors -		
L301	Choke, air cored, 4 turns, 4 mm dia.	07-1200-1900
L302	Choke, air cored, 4 turns, 4 mm dia.	07-1200-1900
L303	Osc. output coupling coil	07-1300-1900
L304	Osc. coil	07-1400-1900
L305	Osc. coil	07-2600-1400
L306	Collector coil	07-2700-1400
L307-318 ~~319~~	Choke 6 µH	07-2000-1400
Resistors -		
R301	Carb. Film 3.3 kΩ ± 5% 1/8W	11-3033-1851
R302	Carb. Film 100 kΩ ± 5% 1/8W	11-4100-1851
R303	Carb. Film ~~33~~ Ω ± 5% 1/8W 39Ω	11-2033-1851
R304	Carb. Film 180 Ω ± 5% 1/8W	11-2180-1851
R305	Carb. Film 27 kΩ ± 5% 1/8W	11-4027-1851
R306	Carb. Film 390 Ω ± 5% 1/8W	11-2390-1851
R307	Carb. Film ~~47~~ kΩ ± 5% 1/8W 100k	11-4047-1851
R308/309	Var. Carb. 10 kΩ 1/4W	14-4010-1451
R310	Carb. Film 220 kΩ ± 5% 1/8W	11-4220-1851
R311	Carb. Film 1 MΩ ± 5% 1/8W	11-5010-1851
R312	Carb. Film 220 kΩ ± 5% 1/8W	11-4220-1851
R313	Carb. Film 1 MΩ ± 5% 1/8W	11-5010-1851
R314	Carb. Film ~~33~~ Ω ± 5% 1/8W 39Ω	11-2033-1851
R315	Carb. Film 180 Ω ± 5% 1/8W	11-2180-1851
R316	Carb. Film 15 kΩ ± 5% 1/8W	11-4015-1851
R317	Carb. Film 5.6 kΩ ± 5% 1/8W	11-3056-1851
R318	Carb. Film 100 Ω ± 5% 1/8W	11-2100-1851
R319	Carb. Film 120 Ω ± 5% 1/8W	11-2120-1851
R325	Carb. Film 2.7 kΩ ± 5% 1/8W	11-3027-1851
R326 (a + b)	Var. Dual 2 x 10 kΩ 1/2W	23-4010-1202
R327	Carb. Film 10 kΩ ± 5% 1/8W	11-4010-1851
R328	Carb. Film 18 kΩ ± 5% 1/8W	11-4018-1851
R329	Carb. Film 18 kΩ ± 5% 1/8W	11-4018-1851
R330	Carb. Film 390 Ω ± 5% 1/8W	11-2390-1851
R331	Carb. Film 15 Ω ± 5% 1/8W	11-2015-1851
R332	Carb. Film 390 Ω ± 5% 1/8W	11-2390-1851
R333	Carb. Film 18 kΩ ± 5% 1/8W	11-4018-1851
R334	Carb. Film 680 Ω ± 5% 1/8W 560Ω	11-2680-1851
R335	Carb. Film 330 Ω ± 5% 1/8W	11-2330-1851
R336	Carb. Film 5.6 kΩ ± 5% 1/8W	11-3056-1851
R337	Carb. Film ~~2.2~~ kΩ ± 5% 1/8W 1.5 kΩ	11-3022-1851
R338	Carb. Film 18 kΩ ± 5% 1/8W	11-4018-1851
R339/340	Carb. Film 1.8 kΩ ± 5% 1/8W	11-3018-1851
R341	Carb. Film 22 Ω ± 5% 1/8W	11-2022-1851
R342	Carb. Film 33 Ω ± 1% 1/8W	11-2033-1851
R343	Carb. Film 297 Ω ± 1% 1/8W	11-2297-1811
R344	Carb. Film 36.6 Ω ± 1% 1/8W	11-7366-1811
R345	Carb. Film 297 Ω ± 1% 1/8W	11-2297-1811
R346	Carb. Film 66 Ω ± 1% 1/8W	11-2066-1811
~~R347/348~~	~~Carb. Film (SIC) 6.8 kΩ - 22 kΩ~~	SIC
~~R349~~	~~Carb. Film (SIC) 100 Ω - 3.3 kΩ~~	SIC
R347	carb film 68k ±5%	
R349	Var. carb. 5k	
R350/351	Var carb 10k	
R352/353	Var Carb 25 k	
R354	carb film 10k	
R355	carb film 4.7k	
R356	carb film 1,8k	

Circuit Reference	Description	M.I. Code No. FPP/
Switches -		
S301	Rotary switch 4 position 4 wafer	61-0404-1201
S302	Co-axial 2 position 1 pole	61-0102-0000
Transistors -		
TR301-302	N channel MOS FET 3N140	84-3300-0140
TR303	Silicon NPN 2N5179	81-2300-5179
TR304	Silicon N channel FET 2N4416	83-2300-4416
TR305	Silicon N channel FET BF256B	83-1210-0256
TR306	Silicon NPN TIS18	81-4400-0018
MAIN CHASSIS ASSEMBLY		
Batteries -		
B401	Battery Dryfit PC 3Bx3F 6 V 1.8 Ah	07-2900-1400
B402	Battery Dryfit PC 3Bx3F 6 V 1.8 Ah	07-2900-1400
B403	Battery Dryfit PC 3Bx3F 6 V 1.8 Ah	07-2900-1400
Capacitors -		
C401	Met. Plas. foil 1.5 μF 100 V	47-5015-0100
C402/403	Cer. Disc. 3,900 pF 150 V A.C.	43-3039-0250
C404	Met. Plas. foil 0.47 μF 100 V	47-4470-0100
C405	Met. Plas. foil 0.1 μF 400 V	47-4100-0400
C406	Elect. Cond 100 μF 15 V	50-6100-0015
Diodes -		
D401	Zener Diode BZY85 C6V8	72-2211-1628
D402	Germanium Diode AA132	70-1100-0132
Fuse -		
FS401	Fuse	07-3500-1400
Inductors -		
L401	Choke Ferrite cored 6 μH	07-2000-1400
L402	Choke Ferrite cored 6 μH	07-2000-1400
Lamps -		
LP401/402	Pilot Lamp Red 24 V 20 mA	09-2400-0020
Loudspeaker -		
LS401	Loudspeaker 8 Ω ½W	07-3400-1400
Meters -		
M401	Meter UDSSp 40 μA	07-3000-1400
M402	Meter UDSSp 40 μA	07-3000-1400
Resistors -		
R401-403	Metal Film 220 Ω ± 2% 1/8W	12-2220-1821
R404	Metal Film 270 Ω ± 2% 1/8W	12-2270-1821
R405	Metal Film 330 Ω ± 2% 1/8W	12-2330-1821
R406	H.F. Voltage divider 60 Ω ½W	24-2050-1601
R407	Var. Carb. Film 1 kΩ ½W	21-3010-1201
R408	Carb. Film 2.2 kΩ ± 5% 1/8W	11-3022-1851
R409	Carb. Film 2.7 kΩ ± 5% 1/8W	11-3027-1851
R410	Var. Carb. Film 2.5 kΩ	21-3025-0901

Circuit Reference	Description	M.I. Code No. FPP/
Resistors (cont)		
R411	Carb. Film 2.2 kΩ ± 5% 1/8W	11-3022-1851
R412	Var. Carb. Film 1 kΩ ½W	21-3010-0901
R413	Carb. Film 470 Ω ± 5% 1/8W	11-2470-1851
R414	Var. Carb. Film 1 kΩ ½W	21-3010-0901
R415	Met. Film 47 Ω ± 2% 1/8W	12-2047-1821
R416	Met. Film ~~390~~ 470 Ω ± 2% 1/8W	12-2390-1821
R417	Met. Film 47 Ω ± 2% 1/8W	12-2047-1821
R418/419	Met. Film 390 Ω ± 2% 1/8W	12-2390-1821
R420	Met. Film 47 Ω ± 2% 1/8W	12-2047-1821
R421	Carb. Film 390 Ω ½W	11-2390-1251
R422	Metal Film 330 Ω ± 2% 1/8W	12-2330-1821
R423	Metal Film 1.5 kΩ ± 2% 1/8W	12-3015-1821
R424	Metal Film 270 Ω ± 2% 1/8W	12-2270-1821
R425	Var. Carb. 1 kΩ Preset 1/8W	13-3010-1851
R426	Var. Carb. 10 kΩ Preset 1/8W	13-4010-1851
R427	Carb. Film 15 kΩ ± 5% 1/8W	11-4015-1851
R428	Var. Carb. 250 Ω Preset 1/8W	13-2250-1851
R429	Carb. Film 220 Ω ± 5% 1/8W	11-2220-1851
~~R430~~	~~Carb. Film 12 kΩ ± 5% 1/8W~~	11-4012-1851
R431	Carb. Film ~~47~~ 68k kΩ ± 5% 1/8W	11-4047-1851
R432	Var. Carb. ~~10~~ 50k kΩ Preset 1/8W	13-4010-1851
R433	Metal Film 100 Ω ± 2% 1/8W	12-2100-1821
R434	Metal Film 220 Ω ± 2% 1/8W	12-2220-1821
R435	Metal Film 680 Ω ± 2% 1/8W	12-2680-1821
R436	Metal Film 2.2 kΩ ± 2% 1/8W	12-3022-1821
R437	Metal Film 6.8 kΩ ± 2% 1/8W	12-3068-1821
R438	Metal Film 22 kΩ ± 2% 1/8W	12-4022-1821
R439	Metal Film 68 kΩ ± 2% 1/8W	12-4068-1821
R440	Carb. Film 2.2 kΩ ± 5% 1/8W	11-3022-1851
R441	Var. Carb. Film 1 kΩ ½W	21-3010-0901
R442	Carb. Film 1 kΩ ± 5% 1/8W	12-3010-1821
R443	Var. Carb. Film 1 kΩ ½W	21-3010-0901
R444	Carb. Film 100 Ω ± 5% 1/8W	11-2100-1851
R445	Carb. Film 820 Ω ± 5% 1/8W	11-2820-1851
R446	Var. Carb. Film (with S408) 50 kΩ ½W	22-4050-0701
R447	Carb. Film 470 Ω ± 5% 1/8W	11-2470-1851
R448	Metal Film 4.7 kΩ ± 2% 1/8W	12-3047-1821
R449	Var. Carb. 5 kΩ Preset 1/8W	13-3050-1851
Switches -		
S401	Switch, Rotary 3 position 5 wafer	61-0603-1201
S402	Switch, Rotary 7 position 1 wafer	61-0107-1201
S403	Switch, Rotary 5 position 4 wafer	61-0405-0801
S405	Switch, Toggle 2 pole 2 throw	64-0202-0000
S405	Switch, Rotary 10 position 3 wafer	62-0310-1201
S406	Switch, Rotary 3 position 3 wafer	61-0303-0301
S407	Switch, Toggle 2 pole 2 throw	64-0202-0000
S048	Switch GANGED to R446	22-4050-0701
Sockets -		
SK401	Mains input socket	07-3200-1400
SK402	BNC socket	07-3300-1400
SK403-405	Terminals 1 x insulated 1 x earthed	07-3400-1400
SK406-409	BNC socket	07-3300-1400

Circuit Reference	Description		M.I. Code No. FPP/
Transformer -			
T401	Mains transformer Pri 110/220 V 350 mA Sec 25/28 V		07-2800-1400
R.F. POWER METER			
Capacitors -			
C501/502	Cer. Disc. 3.3 pF	400 V	41-1033-0400
C503/504	Cer. Feed thro' 1000 pF	400 V	43-3010-0400
C505/506	Tubular 25 pF (Nom.)	400 V	42-2025-0400
C507/508	Cer. Tubular 68 pF	400 V	42-2068-0400
C509/510	Cer disc 6.8pf	400V	
Diodes -			
D501-504	Germanium Diode AA138		70-1100-0138
Resistors -			
R501/502	Carb. Film 100 Ω ± 5% 1/3W		11-2100-1351
R503/504	Carb. Film 150 Ω ± 5% 1/8W		11-2100-1851
R505/506	Carb. Film 4.7 kΩ ± 5% 1/8W 22k		11-3047-1851
R507/508	Carb. Film 47 kΩ ± 5% 1/8W		11-4047-1851
R509/510	Var. Carb. 50 kΩ Preset 1/8W 25k		14-4050-1851
R511/512	Carb. Film 100 Ω ± 5% 1/3W		11-2100-1351
R513/514	Carb. Film 4.7 kΩ ± 5% 1/8W 22k		11-3047-1851
R515/516	Carb. Film 47 kΩ ± 5% 1/8W		11-4047-1851
R517/518	Var. Carb. 50 kΩ Preset 1/8W 25k		14-4050-1851
R519	Carb. Film 50 Ω ± 2% 10 W		11-2050-1021
R520/821	Carb film 1000Ω ±5% 3W		
L 505/506	Choke air wound 12 turns on Resistor		

CIRCUIT NOTES

1. ARRANGEMENT

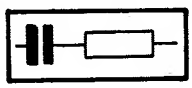
   The inter unit wiring diagram Fig. 7.1 shows all sub-assembly units

2. VOLTAGES

   Printed in italics. Signal voltage are suffixed by the abbreviation "pp" meaning peak to peak value

   D.C. voltages are relative to chassis unless otherwise indicated.

4. SYMBOLS

Test point 2	
Signal path	
Front panel marking	
Boxed circuitry indicates electrical screen	

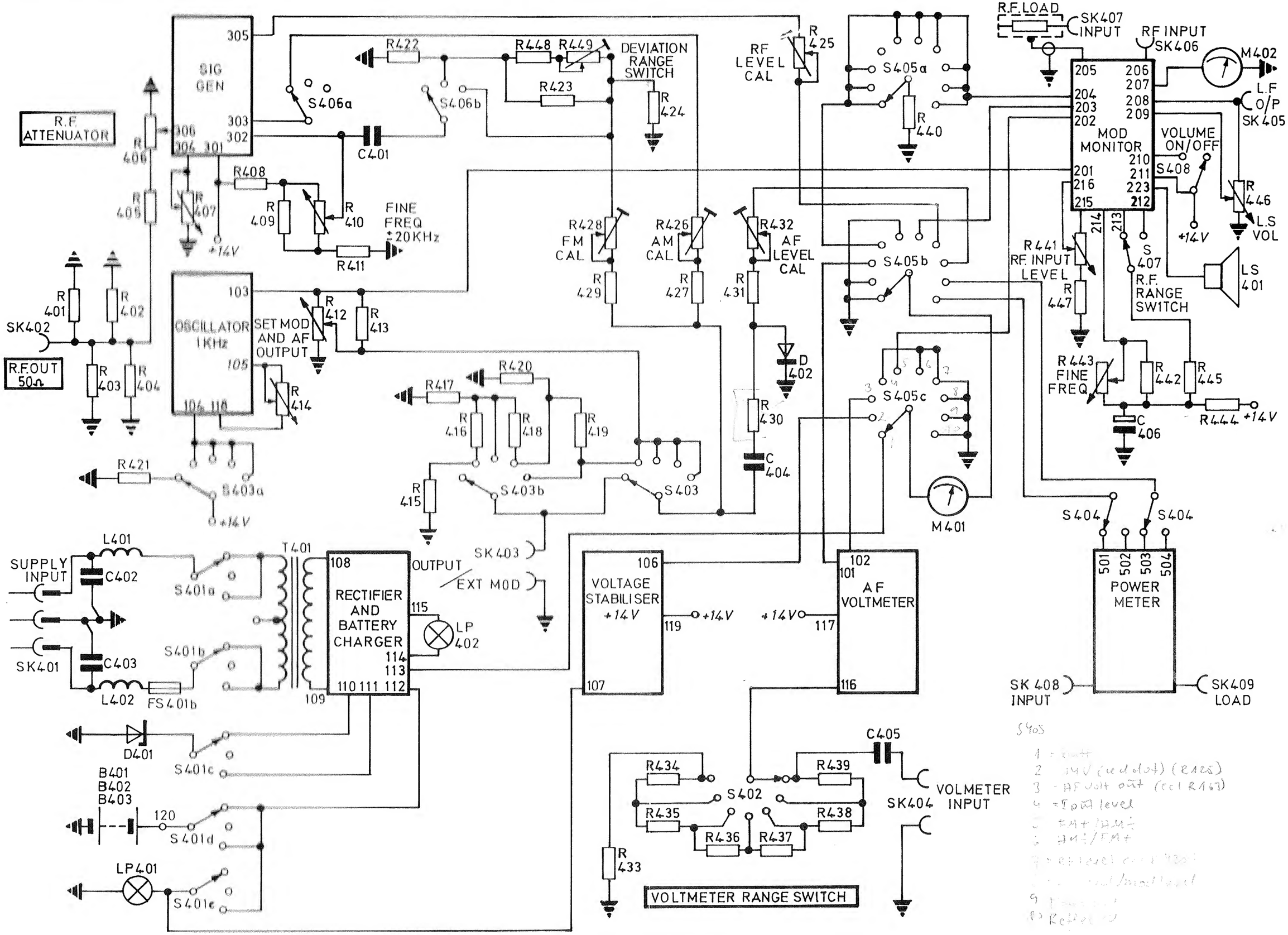


Fig. 7.1 Inter-Unit Wiring Circuit Diagram

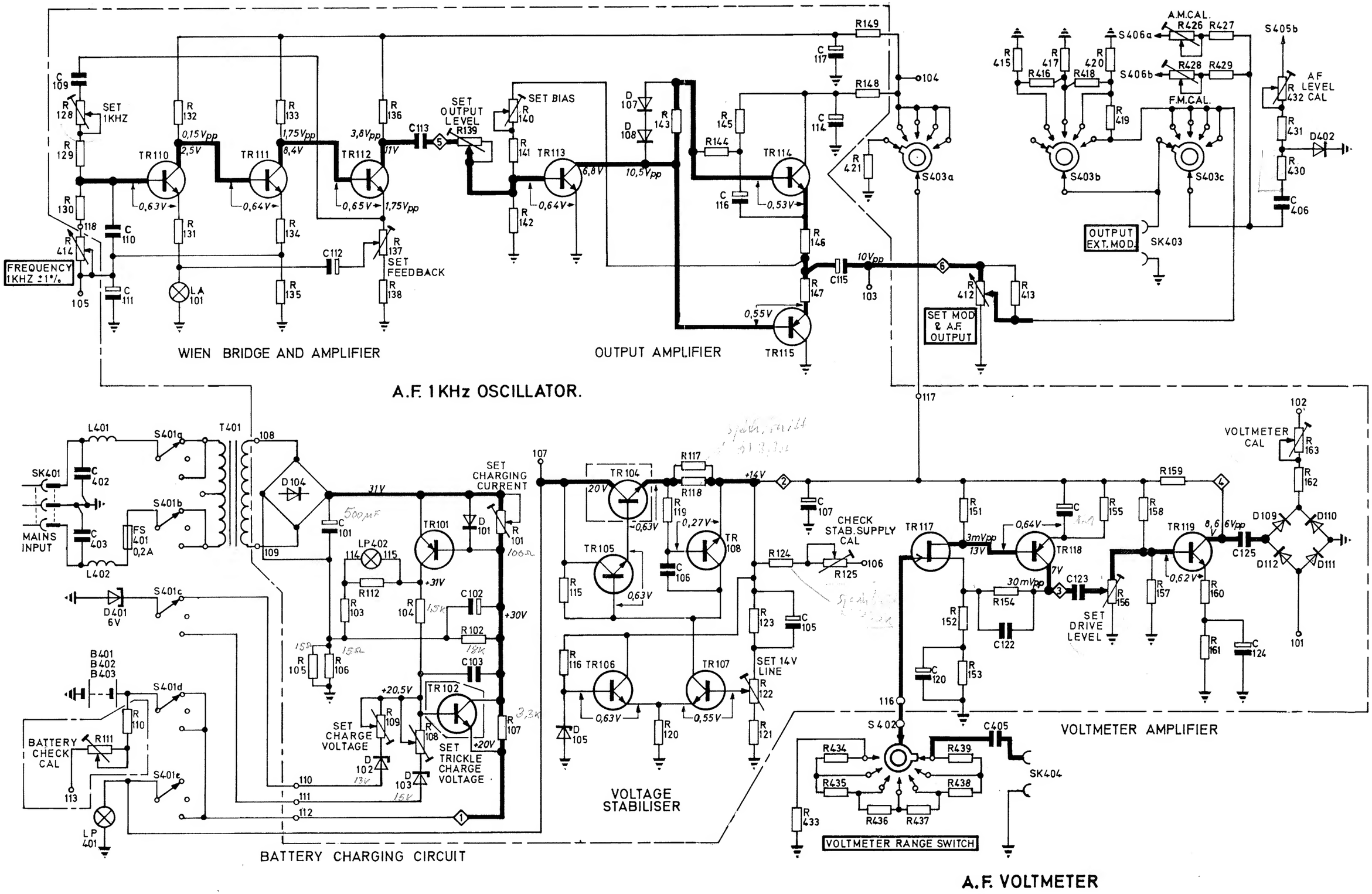


Fig. 7.2 Power Supply, A.F. 1 kHz Oscillator, A.F Voltmeter Circuit Diagram

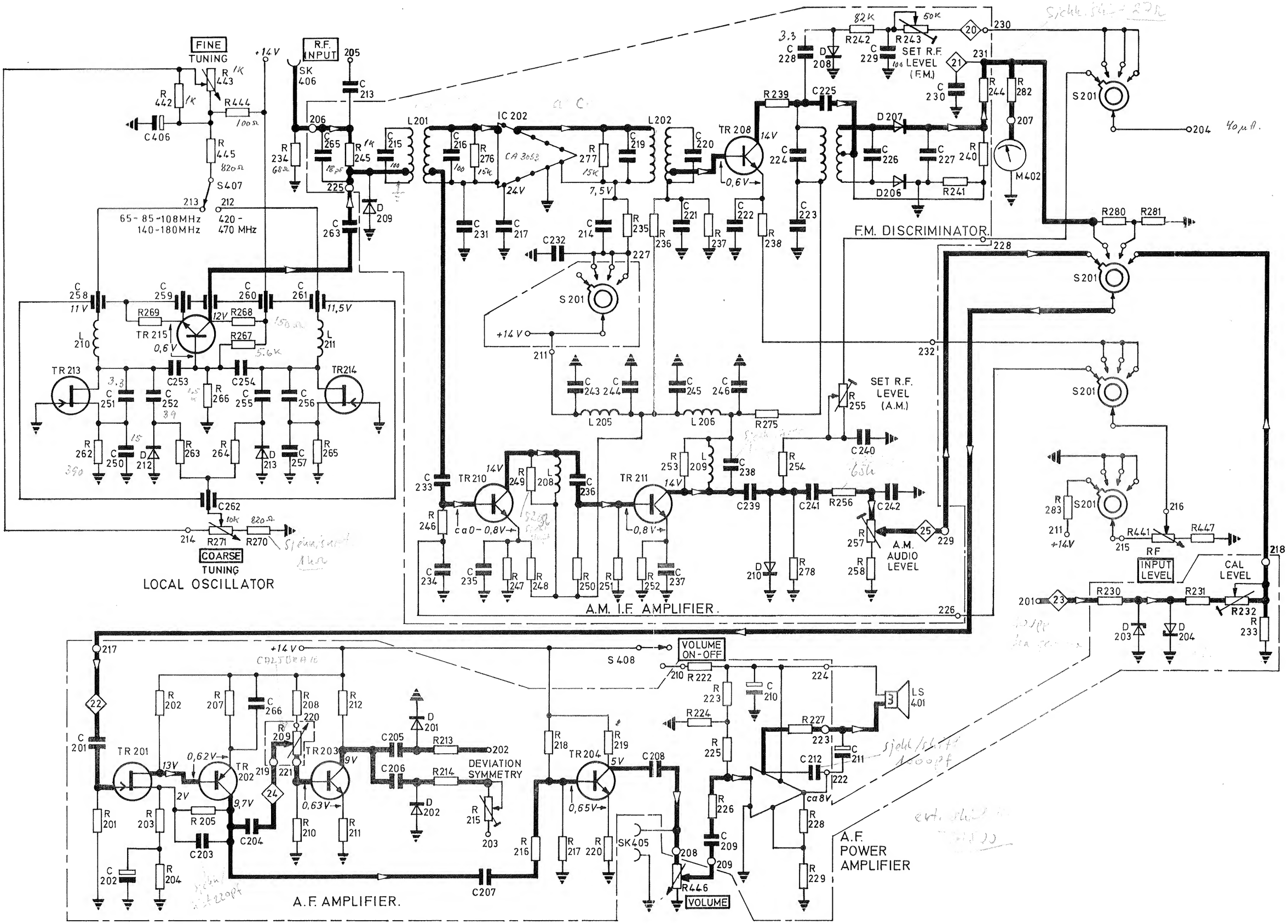


Fig. 7.3 Modulation Monitor Circuit Diagram

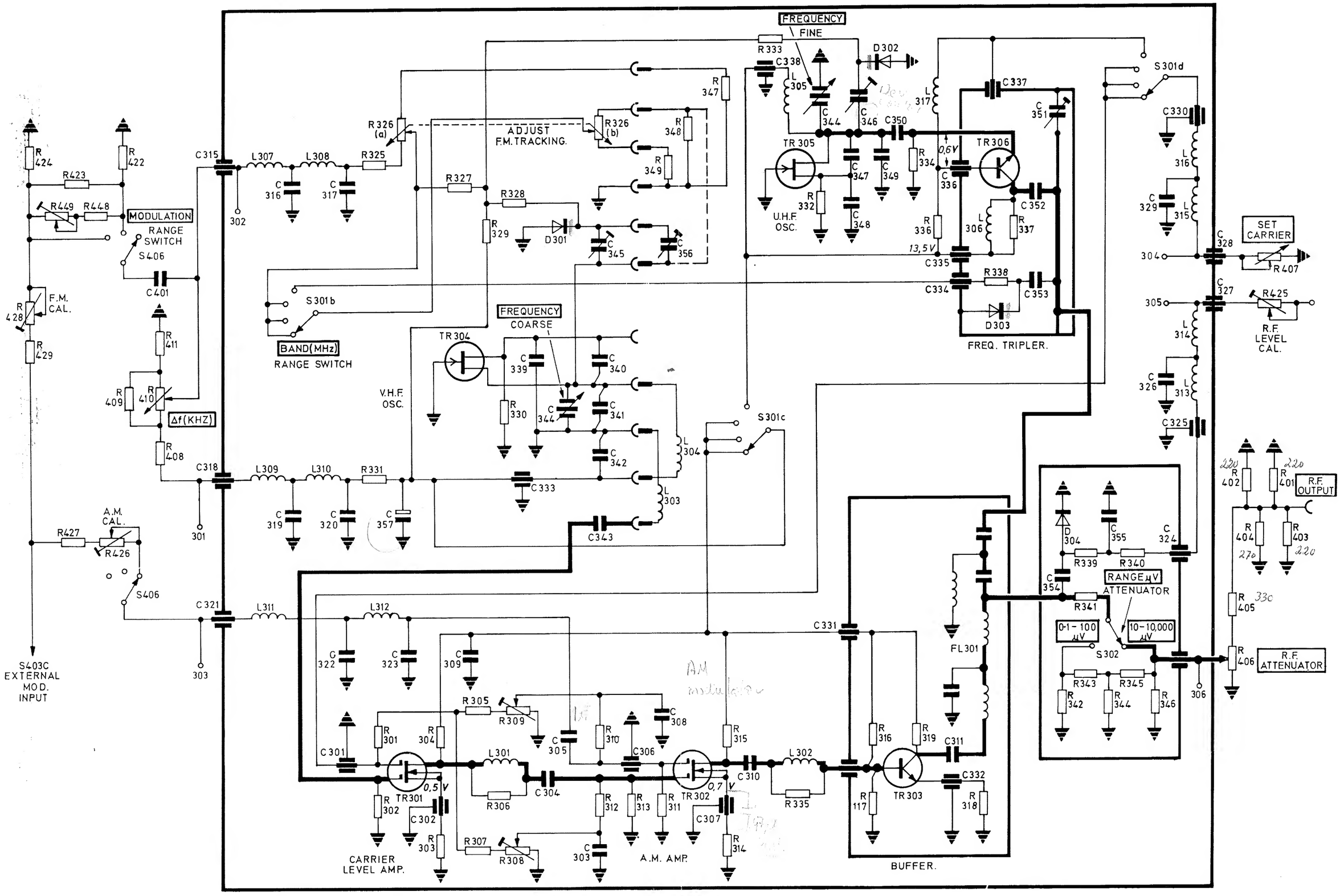


Fig. 7.4 VHF/UHF AM/FM Signal Generator Circuit Diagram

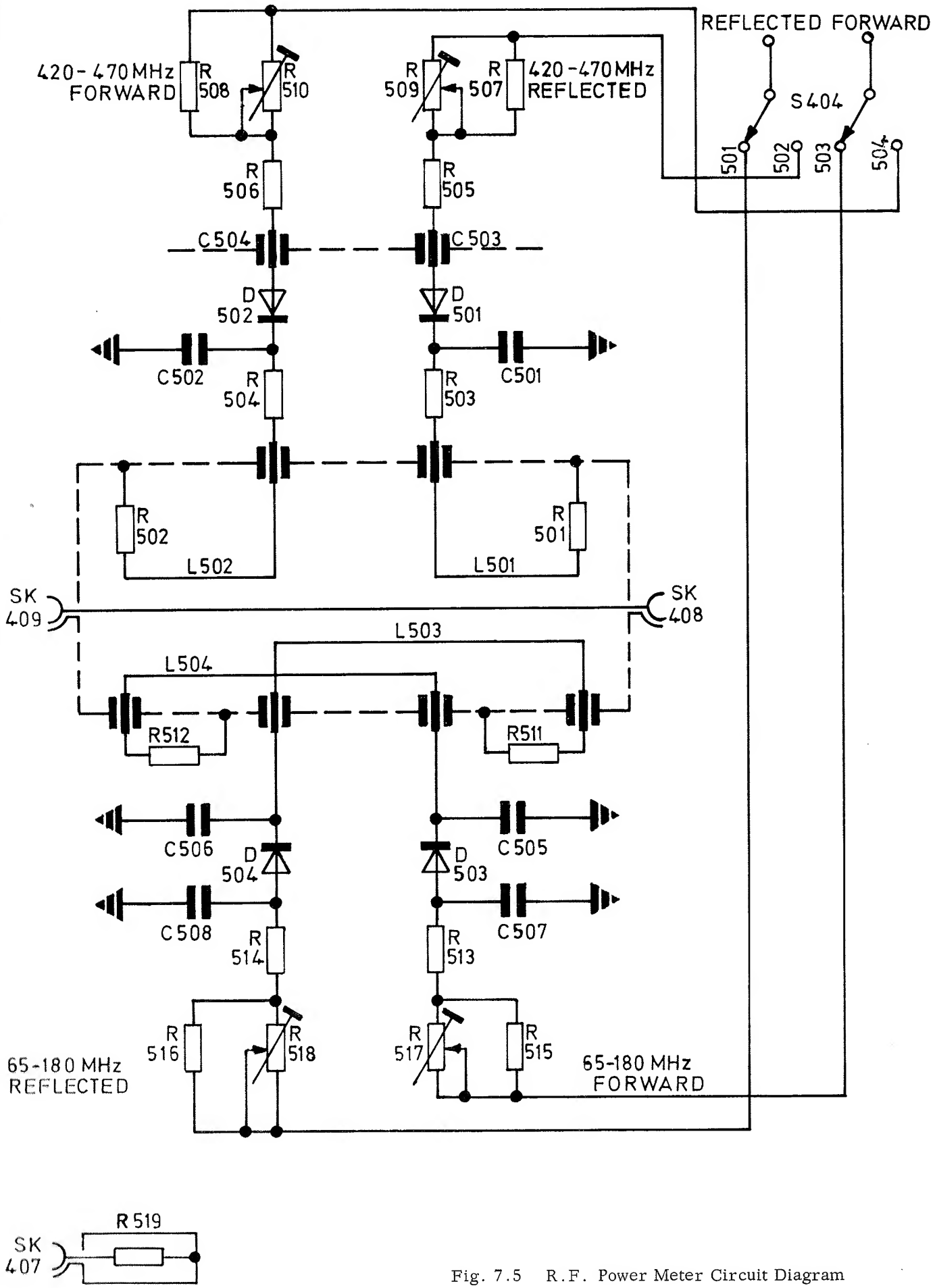


Fig. 7.5 R.F. Power Meter Circuit Diagram

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MANUAL CHANGES
for
MOBILE RADIO TEST SET TF 2950

Changes and errata - The following changes refer to current production. For maintenance purposes the type called for in the original handbook may be used.

Page 24 FIG 5. 1 POWER SUPPLY AND VOLTAGE STABILISER
Amend circuit reference numbers as follows -

D102 to read D103
D103 to read D102
R109 to read R108 and change title to read -
SET TRICKLE CHARGE VOLTAGE
R108 to read R109 and change title to read -
SET CHARGE VOLTAGE

Page 27 Amend description of D104 to read -
Selen. Rect. B30C 450/700
Amend value of R117/118 to 3.3Ω

Page 28 Change value and code number of R124 as follows -
470 kΩ 11-4470-1851
Amend description of R136 to read -
Carb. Film

Page 29 Change value and code number of C203 as follows -
220 pF 46-2220-0100
Change value of C212 as follows -
1000 pF

Page 30 Amend value of C213 to read -
6.8 pF

Page 31 Change type/value and code numbers of the following components -

IC202	CA3043	85-5500-3043
R244	27 Ω	11-4027-1851
C238	Styroflex 100 pF 100 V	46-2100-0400

Page 32 Add C245 after C243-246 as follows -

C245	Cer.Disc 0.1 µF 63 V	43-4100-0063

Change values and code numbers of the following components

R249	820 Ω	11-2820-1851
R256	68 kΩ	11-4068-1851

Page 33 Change type/value and code numbers of the following components -

R270	1 kΩ	11-3010-1851
C301-303	Cer. Disc 22 000 pF	43-4022-0063
C305	1 µF	47-5010-0100
C353	5.6 pF	41-1056-0400

Delete C306-309 and C310

Add -

C357/358	Cer. Disc 22000 pF 63 V	43-4022-0063
C359	Tantalum 47 µF 6 V	50-6047-0006
C306	Cer. Disc 1000 pF 400 V	43-3010-0400
C307-309	Cer. Disc 22000 pF 63 V	43-4022-0063

Page 34. Change L307-318 to read L307-319

Change values and code numbers of the following components

R303	39Ω	11-2039-1851
R307	100 k	11-4100-1851
R314	39Ω	11-2039-1851
R334	560Ω	11-2560-1851
R337	1.5 kΩ	11-3015-1851

Delete R347/348 and R349

Add -

R347	Carb Film 68 kΩ ± 5% 1/8 W	11-3068-1851
R349	Var. Carb 5 kΩ ¼W	14-3050-1451
R350/351	Var. Carb 10 kΩ ¼W	14-4010-1451
R352/353	Var. Carb 25 kΩ ¼W	14-4025-1451
R354	Carb Film 10 kΩ ± 5% 1/8 W	11-4010-1851
R355	Carb Film 4.7 kΩ ± 5% 1/8 W	11-3047-1851
R356	Carb Film 1.8 kΩ ± 5% 1/8 W	11-3018-1851

Page 35 Change TR 306 type and code number as follows -

TR306	Silicon NPN 2W5179	81-2300-5179

Amend description of C402/403 to read -

C402/403 Cer. Disc. 3,900 pF 250 V a.c.

Amend type and code number of M402 to read -

M402	Meter P45 ± 40 µA	07-3100-1400

Page 36 Change value and code numbers of the following components

R416	470 Ω	12-2470-1821
R431	68 kΩ	11-4068-1851
R432	50 kΩ	13-4050-1851

Delete R430

Page 37 Change values and code numbers of the following components

R505/506	22kΩ	11-4022-1851
R509/510	25 kΩ	14-4025-1451
R513/514	22 kΩ	11-4022-1851
R517/518	25 kΩ	14-4025-1451

Delete R507/508, R515/516

Add-

C509/510	Cer. Disc 6.8 pF 400 V	41-1068-0400
R520/521	Carb. Film 100Ω ± 5% 1/3 W	11-2100-1351
L505/506	Choke air cored 12 turns of resistors	07-1210-1900

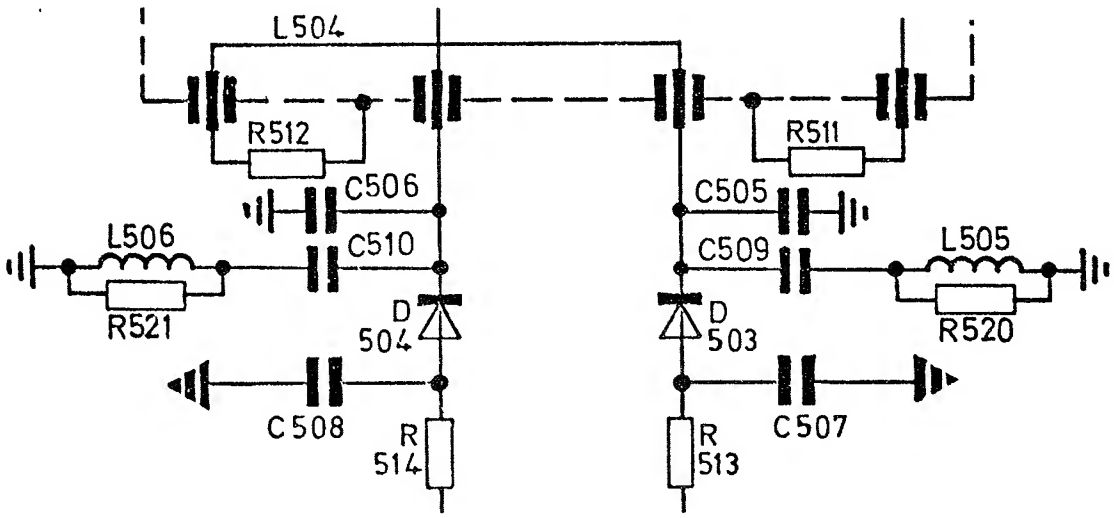
FIG 7.1 Delete R430

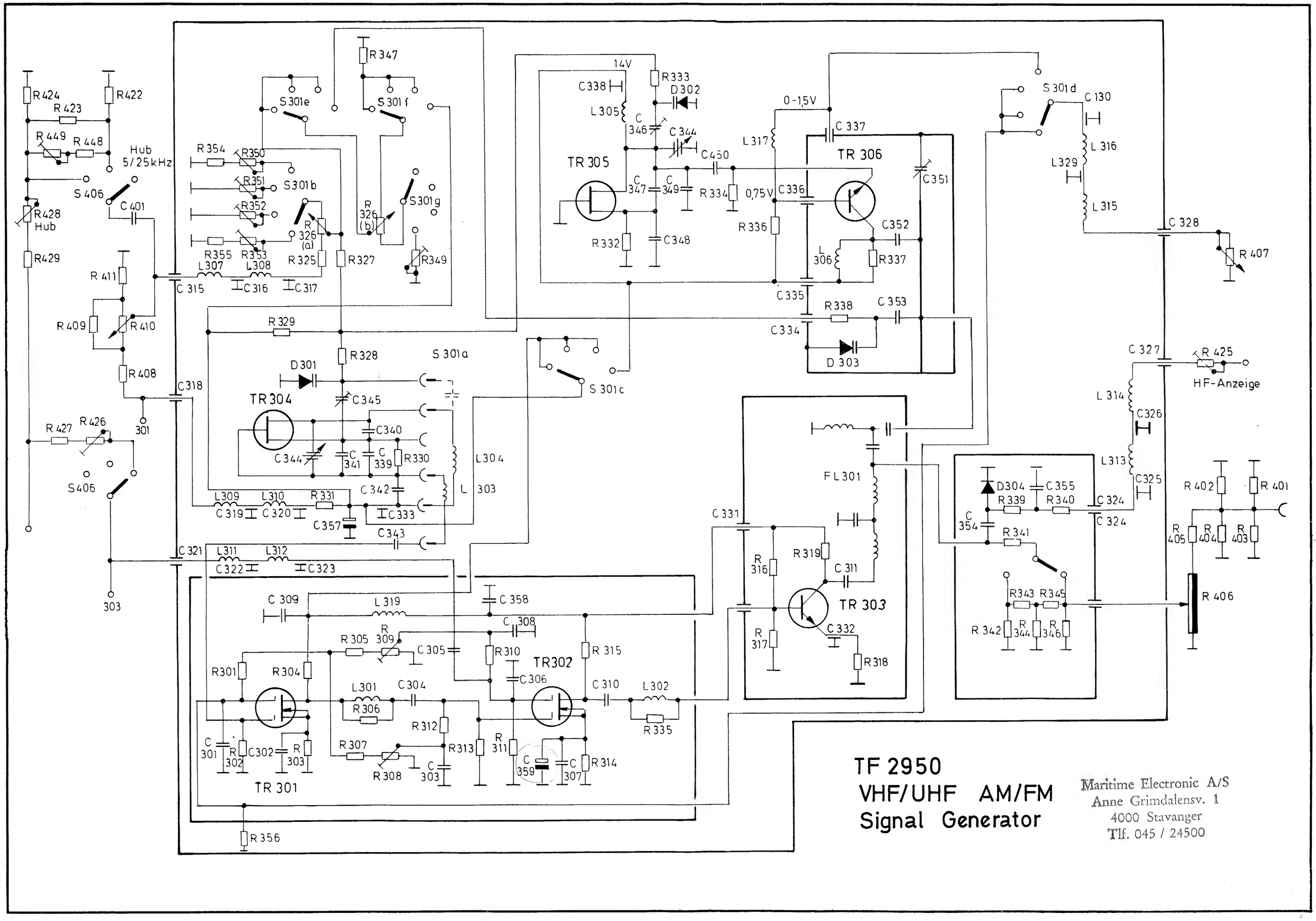
FIG 7.2 Delete R430

FIG 7.4 Amend as indicated in the last page of this change

FIG 7.5 Amend as indicated below -

Add L505/506 and R520/521
Delete R507/508 and R515/R516




R424
R422
R423
R449
R448
Hub
5/25kHz
S406
C401
R428
Hub
R429
R411
R409
R410
R408
C318
R427
R426
301
S406
303
R347
S301e
S301f
R354
R350
R351
S301b
R352
R
326
(a)
R355
R353
L307
L308
C315
C316
C317
R325
R327
R
326
(b)
S301g
R349
R329
R328
S301a
D301
TR304
C345
C340
C344
C
341
C
339
R330
L304
L309
L310
R331
C342
L
303
C319
C320
C333
C357
C343
C321
L311
L312
C322
C323
S301c
14V
R333
D302
C338
L305
C
346
C344
TR305
C450
C
347
C
349
R334
R332
C348
0-1,5V
L317
C337
TR306
C351
0,75V
C336
R336
C352
L
306
R337
C335
R338
C353
C334
D303
S301d
C130
L316
L329
L315
C328
R407
C327
R425
HF-Anzeige
L314
C326
L313
C325
R402
R401
R405
R404
R403
R406
FL301
C331
R
316
R319
C311
TR303
C332
R
317
R318
D304
C355
R339
R340
C324
C
354
R341
R343
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C358
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309
C305
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TR302
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R306
R312
R335
C
301
R
302
C302
R
303
R307
R313
R
311
R314
R308
C
303
C
359
C
307
TR301
R356
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